SOIL SURVEY OF THE BERNARDSVILLE AREA, NEW JERSEY.

By AUSTIN L. PATRICK, In Charge, and E. B. DEETER, of the U. S. Department of Agriculture, and C. C. ENGLE and L. L. LEE, of the Department of Conservation and Development of New Jersey.

DESCRIPTION OF THE AREA.

The Bernardsville area, comprising nearly all of Morris and Somerset Counties and small parts of Middlesex, Union, Essex, Sussex, and Hunterdon Counties, is situated in the central part of northern New Jersey. In outline the area is rectangular. Its length north and south is 32 miles, and its width is nearly 23 miles. Its land area is 725 square miles, or 464,000 acres.[1]

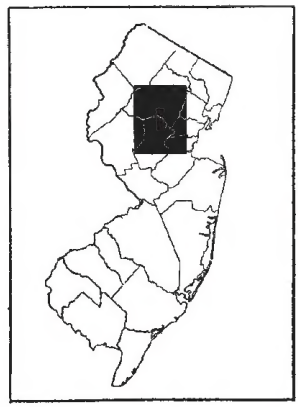


FIG. 9.—Sketch map showing location of the Bernardsville area, New Jersey.

The physiography of the area varies considerably and includes low-lying plains, prominent ridges, and high uplands cut by many valleys. It consists of three physiographic divisions, or geographic provinces—Coastal Plain, Piedmont Plain, and Highlands. (See Pl. XIV.)

The Coastal Plain part of the area is located on both sides of the Raritan River east of New Brunswick and south of Metuchen, in the extreme southeastern corner of the area. It ranges in elevation from sea level to 100 feet above sea level and has a gently sloping to nearly flat topography.

The Piedmont Plain occupies all of the remaining part of the Bernardsville area except the northwestern quarter. It consists of a broad, nearly flat to gently rolling region cut rather deeply by the larger streams and broken in the northeastern and east-central parts of the area by the high curving ridges of the Watchung Mountains and in the extreme southwest corner by a point of Sourland Mountain. These mountains rise abuptly from 200 to 400 feet above the general level of the region.

The Highlands occupy the northwestern section of the area and consist of high, rolling, plateaulike country cut deeply by many

[1] The base map used is sheet No. 25 of the New Jersey State Topographical Atlas.

streams and rather narrow stream valleys, the widest of which is an extension of the Raritan Valley near the headwaters of the south branch of the Raritan River. The general elevation of this section is between 900 and 1,000 feet above sea level, though there are a number of knolls which have an elevation of over 1,200 feet. The elevation of the valleys is from 300 to 400 feet lower. The slopes and valley sides are as a rule steep and rough.

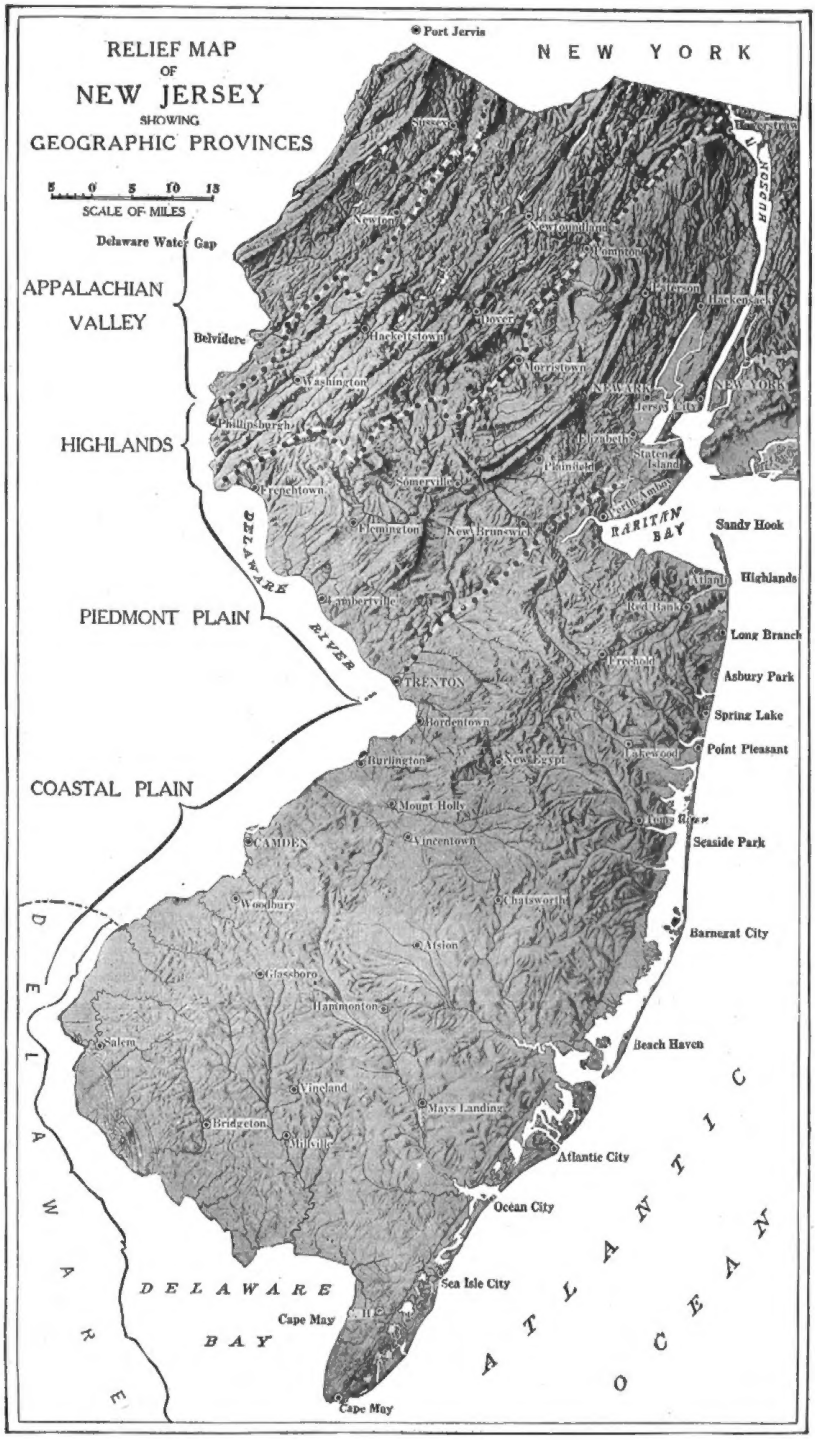
The surface drainage of the area enters the Atlantic Ocean through the Raritan and Passaic Rivers. The northwestern and southern sections drain into the Raritan River. Both the north and south branches of the Raritan head in the northwestern part of the area. The most important tributaries of the Raritan are the Black or Lamington River, Rockaway Creek, and Millstone River. The general course of the Raritan is south and southeast. The Passaic River and its tributaries, of which the Rockaway and Whippany Rivers are the most important, carry off the surface waters of the northeastern and east-central sections. The general slope is north to northwest, but the river changes its direction many times before it finally empties into Newark Bay.

The region lying in the Raritan drainage basin as a whole is well drained, but the Passaic basin includes numerous large swamps, among which Great Swamp, Black Meadows, and Troy Meadows are the largest. In the Highlands and Piedmont sections many of the streams have cut their valleys and channels 200 to 400 feet below the general level of the surface. The valleys are deeper in the Highlands than elsewhere. The streams are still actively cutting down, and water power could be developed in many places. Many old mills have been in operation in the past.

In the northern third of the Bernardsville area there are a number of lakes of varying size. Many of these, such as Mountain Lakes, Budd Lake, Lake Hopatcong (the south half of which extends into the area), White Meadow Lake, and Silver Lake, are summer resorts of importance. Ice is cut from all of them in winter and stored in large houses for later use.

Charles II granted New England and the country west to the Delaware River to his brother James, Duke of York, on March 12, 1664. Previous to this the Dutch had made settlements on Manhattan Island and Staten Island and some adjacent parts of New Jersey. Shortly after the grant the English captured the Dutch settlement on Manhatten Island, and James transferred New Jersey to Lord Berkeley and Sir George Carteret by deed in July, 1676.

It is claimed that all the territory was purchased from the Indians either by the Board of Proprietors or by the settlers, and in general it may be said that land titles go back to grants made by the two Boards of Proprietors who succeeded to the property rights of Carteret



GEOGRAPHIC PROVINCES OF NEW JERSEY.

in East Jersey and William Penn and his associates in West Jersey. These Boards of Proprietors still retain corporate existence, with offices at Perth Amboy and Burlington, respectively.

In 1682 East Jersey was divided into four counties, Bergen, Essex, Middlesex, and Monmouth. Somerset was cut off from Middlesex in 1688, and additional territory was given it at the expense of Middlesex in 1709. Union County was later set off from Essex County, and Morris County was set off from Hunterdon County. At first Morris County was nearly all in West Jersey, but later, according to the boundary line agreed to by the two provinces, all of Morris County except the western part was given to East Jersey.

The earliest settlements were made in the southeast and south-central part of the area, on land now included in Middlesex, Union, and Somerset Counties, between the years of 1650, or before, and 1670. Morris County was settled shortly afterwards. The English, Scotch, New Englanders, Dutch, and Germans all played important rôles in the early settlement. Many of these early settlers were Quakers. Some of the very earliest settlements were made at Piscataway, Bound Brook, Plainfield, Scotch Plains, Pluckemin, Hanover, Whippany, and Basking Ridge.

The descendants of many of the original settlers live in the section to-day. Of late years an increasing number of foreign-born whites from Russia and southern Europe have settled here, particularly in and near the industrial towns of Dover, Morristown, Plainfield, Somerville, New Brunswick, and Raritan. They are more numerous in the towns, but they also constitute the greater proportion of the truck farmers or market gardeners near these towns.

According to the census of 1920, the population of Somerset County is 47,991 and that of Morris County is 82,694. One-half of the people in Somerset County and 50.4 per cent in Morris County live in towns with populations of 2,500 or more. The average rural population per square mile in Somerset County is 78.7 persons, and in Morris County the average per square mile is 86.4 persons. The parts of Union and Middlesex Counties included in the area are much more thickly populated than those of the greater part of the area, owing to their location with reference to New York and other cities.

According to the 1920 census, the largest towns in this area, which contains hundreds of towns, are the following: New Brunswick, county seat of Middlesex County, with a population of 32,779, comes first; Plainfield is second with 27,700 persons; Morristown, the county seat of Morris County, has a population of 12,548; Summit, 10,174; Dover, 9,803; Westfield, 9,063; Somerville, the county seat of Somerset County, 6,718; and Boonton, 5,372. The towns are

both industrial and commuting centers. Many of the inhabitants work in New York and other near-by cities and go back and forth daily on the trains.

The area is exceptionally well supplied with railroads, trolleys, and improved highways. Most of the important railroads connecting New York City with the southern and western sections of the United States traverse this area. Among these are the Pennsylvania, Baltimore & Ohio, Philadelphia & Reading, New Jersey Central, Lehigh Valley, and Delaware, Lackawanna & Western. In addition there are many branch lines, so that all parts of the area are well served with railroad transportation. The counties and the State have built numerous excellent roads and are planning the construction of many more.

In addition to the numerous towns in the area, the cities of New York, Newark, Jersey City, and Hoboken and their suburbs are within 30 miles of the center of the area, so that the farmers have ready access to markets for their produce.

CLIMATE.

The climate of the Bernardsville area is characterized by cold winters and moderately warm summers. The coldest temperature ever recorded was −21° F. in the month of January, and the warmest or the absolute maximum was 109° F. in the month of September. Such extreme temperatures are very unusual, for even in the very coldest months the thermometer seldom remains below zero for more than a day or two at a time, and during the summer it seldom registers 100° F. and never remains that warm for many days. The mean temperature during the winter months for the whole area is 29° F., and for the summer months it is 70.5° F. January is the coldest month and July is the warmest.

The average annual rainfall is about 48 inches. Most of this falls during the summer months. It is sufficient to mature crops, especially since it is well distributed throughout the growing season. The average annual snowfall amounts to 40.2 inches. It seldom causes much trouble, owing to the fact that, as a rule, the severe storms are of short duration. The main trouble comes from the drifting caused by wind. Sleet sometimes interferes seriously with suspended wires for the transmission of power by electricity.

There is considerable variation in climate in the different parts of the area. This is marked especially in the length of the growing season, as gauged by the date of last killing frost in the spring and the first one in the fall. Thus, at Dover the average growing season is 157 days from May 4 to October 7; while at New Brunswick the

growing season averages 181 days from April 19 to October 17. This amounts to a difference of 24 days, or four-fifths of a month. A still greater difference would be shown if records were available for the extreme northern sections at higher elevations than Dover. The length of the season has a marked effect on the growing of crops.

Often corn will fail to mature in the northern part of the area and fruit buds will be killed, when these crops succeed in the southern part. More hardy, quicker maturing varieties are in common use in the northern part. Thus, on the higher elevations many of the farmers plant rye instead of wheat and flint corn for grain instead of the softer or dent varieties. Some damage is done each winter by alternate thaws and freezes. Clover, alfalfa, wheat, and rye sometimes "heave" and winterkill.

The following tables give the more important climatic data recorded at the Weather Bureau stations at Somerville and Dover.

Normal monthly, seasonal, and annual temperature and precipitation at Somerville.

[Elevation, 60 feet.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1895).	Total amount for the wettest year (1902).	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	31.9	67	−18	3.57	2.37	7.71	4.6
January	29.2	70	−20	3.48	3.48	2.94	8.8
February	30.0	68	−12	3.55	1.03	5.77	11.2
Winter	30.4	70	−20	10.60	6.88	16.42	24.6
March	36.9	85	−4	3.95	3.19	4.49	6.2
April	48.7	95	15	3.55	4.46	3.73	.4
May	60.1	99	26	4.12	3.22	1.84	.0
Spring	48.6	99	−4	11.62	10.87	10.06	6.6
June	69.2	102	37	4.15	3.36	5.33	.0
July	73.9	107	45	5.13	4.67	5.52	.0
August	71.9	102	43	4.71	2.91	8.30	.0
Summer	71.7	107	37	13.99	10.94	19.15	.0
September	65.3	109	29	3.66	.70	5.72	.0
October	53.4	95	20	3.41	3.89	6.71	.0
November	42.2	79	7	3.39	3.32	1.41	2.2
Fall	53.6	109	7	10.46	7.91	13.84	2.2
Year	51.1	109	−20	46.67	36.60	59.47	33.4

Normal monthly, seasonal, and annual temperature and precipitation at Dover.

[Elevation, 600 feet.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1895).	Total amount for the wettest year (1903).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	30.1	62	−14	4.12	2.98	5.25	7.0
January	26.6	66	−21	4.49	4.04	4.79	12.5
February	26.2	60	−10	4.24	.77	4.05	15.2
Winter	27.6	66	−21	12.85	7.79	14.09	34.7
March	34.9	83	−4	3.90	2.11	5.49	8.0
April	47.3	93	14	3.51	5.22	4.34	1.3
May	58.6	99	27	4.14	2.66	.37	.0
Spring	46.9	99	−4	11.55	9.99	10.20	9.3
June	67.2	100	37	4.12	3.94	15.02	.0
July	71.4	102	42	5.48	3.97	5.47	.0
August	69.2	100	40	5.00	2.37	9.04	.0
Summer	69.3	102	37	14.60	10.28	29.53	.0
September	62.6	99	28	4.48	.64	3.39	.0
October	50.7	89	19	4.00	4.16	10.77	.0
November	40.3	76	8	3.63	2.47	1.27	3.1
Fall	51.2	99	8	12.11	7.27	15.43	3.1
Year	48.8	102	−21	51.11	35.33	69.25	47.1

AGRICULTURE.

The early settlers in the Bernardsville area were compelled to clear the land of its hardwood timber and in many places remove the larger stones before crops could be grown. Corn was grown in patches by the Indians long before the coming of the white men. At first, corn, oats, rye, wheat, and flax were the most important crops. Hogs, sheep, and cattle were branded or marked and allowed to roam at large. The pioneers were forced to depend wholly upon what they raised and the game they killed for food and clothing. During flood periods the streams were used to some extent to transport farm and forest products to market. Animals that were to be sold were driven on foot to the market place. Whiskey was one of the early products, as it was a concentrated way of marketing grain. Later, wagon roads were improved. In 1831 the Morris Canal was constructed, and the Delaware and Raritan Canal was completed about 1833. About the same time work was begun on railroad beds. The first railroads were short lines connecting towns a few miles

apart. These were gradually extended to the present-day systems. With the construction of the main railroads the real agricultural development of the region began.

Cattle raising has always been an important branch of agriculture, owing to the good natural growth of grasses. The different changes in this form of industry have kept pace with the development of the means of transportation. Thus, meat production was the first object of the cattlemen; slowly dairy cows were substituted for the beef animals, and butter and cheese came to be the important products. To-day the Holstein blood is predominant, since the object is to obtain whole milk. Sheep and hog raising has decreased, although nearly every farmer raises enough pork to supply home needs and in many cases has a surplus to sell. Sheep are not raised to any great extent because of trouble with dogs.

Peach growing was of primary importance a few years ago. In 1890, in Somerset County alone, there were 539,243 trees, but in 1910 the number had decreased to 70,258, and in 1920 the number of trees of bearing age reported was 72,947, with 18,727 nonbearing trees. This has been due largely to the development of the large peach-producing centers on the sandier soils of southern New Jersey and to lack of proper treatment. The census also shows a marked decrease in the number of apple trees, and this is probably due to a considerable degree to the natural dying off of the old family orchards, which have not been replaced.

At present the agriculture consists of general farming combined with dairying. Poultry products are important on nearly all farms, though there are but few exclusively poultry farms. The chief cash crop is wheat; but in places rye and buckwheat are grown for sale. Hay, corn, and oats are the principal subsistence crops, and only the surplus of these is sold.

According to the census, the total area in cultivated grasses in Somerset and Morris Counties in 1919 was 40,183 acres, yielding 44,940 tons of hay.[2] Of this there were 18,485 acres in mixed timothy and clover, 14,346 acres in timothy alone, 2,149 acres in clover alone, and 2,840 acres in alfalfa. Only 256 acres of alfalfa were reported for the two counties in the 1910 census. Of the other tame grasses millet is of considerable importance. Due to the increasing number of automobiles and trucks in the cities, hay production for other than subsistence purposes is on the decline. The acreage of tame grasses is only about two-thirds as large as it was 10 years ago. Silage crops occupied 2,393 acres in 1919, and corn was cut for forage

[2] In giving crop statistics of this area the figures for Morris and Somerset Counties alone will be given. The total extent of these two counties is about the same as of the area surveyed, and the parts of these counties not included in the area surveyed are very similar to the included parts of Hunterdon, Middlesex, and Morris Counties. Parts of Middlesex and Morris Counties, however, are more thickly settled, and so the figures for the area surveyed, if they were obtainable, would be slightly different.

from 7,745 acres. This is a marked increase over the acreage of similar forage crops reported for 1909.

Corn for grain was grown on 25,145 acres in the two counties in 1919, with a production of 946,287 bushels. This does not include the acreage of corn cut for silage and for forage. Oats were grown on 16,077 acres, producing 327,041 bushels. Wheat was raised on 13,797 acres, yielding 220,757 bushels; rye on 8,115 acres, yielding 105,138 bushels; buckwheat on 2,009 acres, yielding 25,399 bushels.

Potatoes and other truck crops are of importance near the large towns on certain soils in Union and Middlesex Counties. Peaches, apples, and pears are important locally, and in a few places small-fruit production is of importance. Near New Providence, Summit, and Chatham there are a number of very large greenhouses devoted to growing flowers, mainly roses.

Dairying is the leading industry on a majority of the farms. According to the census there were 19,485 dairy cattle in the two counties on January 1, 1920, of which about 70 per cent are classed as milk cows. The value of the dairy products, exclusive of milk and cream used in the home, for 1919 was reported as $2,005,127. The greater part of the income from dairy products is derived from the sale of whole milk in neighboring cities.

Statistics concerning the number and value of animals sold or slaughtered in 1919 are not available. The value in 1909 was reported as $600,630. Hogs and calves made up the greater part of the animals sold or slaughtered. On many of the estate farms the raising of blooded horses, cattle, and hogs is important. Sheep are kept by a few farmers.

The poultry industry is of considerable importance. There were 271,534 chickens reported on January 1, 1920, and the value of the chickens and eggs produced in 1919 is given as $1,095,689.

The topography and the character of soil have had some bearing on the type of agriculture. Thus, in the northern part of the area, on the ridges of the Highlands, rye is usually grown instead of wheat, and here also flint corn is usually grown for grain, while in the lowlands dent corn is used. The sandier soils of the Merrimac, Dunellen, and Sassafras series are used much more extensively for the production of vegetables than are the heavier members of the same and other series.

The area is so large and includes so many different soils that the farmers in one end of the area know little about the soil adaptations of the other end. However, it is generally understood throughout the area that the Montalto and Chester soils are exceptionally good peach and apple soils, that the general farm crops do better on the heavier soils, such as the loams and silt loams; and that the first-bottom soils are generally better suited to pasturing than to other uses. It is known that corn and clover do not give good yields on

the Whippany, Watchung, Croton, and Roanoke soils. These soil adaptations to some extent govern the farm practices.

The farm buildings are well constructed, large, and numerous (Pl. XV, Fig. 1). Since this section has been settled for hundreds of years, and each generation has added some improvements, it appears natural to find that a rather large proportion of the total farm value is in buildings. These constitute nearly 40 per cent of the entire farm value. The laws regarding milk production in the State are very strict and usually are rigidly enforced, and as a result the cow stalls, which are usually situated on the ground floor of the barn, are well lighted and are well kept. The upper parts of the barns are constructed to hold large quantities of unbaled hay and straw. Some hay and straw is stacked outside or put up in a peculiar form of shed called a "barracks." The roof of the barracks can be raised or lowered as the size of the stack increases or decreases. In addition to the barn and house, there are usually a number of smaller buildings, including sheds for farm machinery, garage, tool houses, chicken houses, hog houses, and silos.

The farm implements are numerous and constitute over 5 per cent of the entire farm value. Such modern farm machinery as threshers, shellers, feed grinders, gasoline engines, drills, manure spreaders, two-row corn planters, two-row cultivators, corn harvesters, reapers, and binders are found on most of the farms. In recent years, owing to the high cost and scarcity of efficient labor, tractors have become very popular. The smaller tractors appear to be more in demand than the larger types. Motor trucks are owned by many of the larger farmers and are used for hauling milk and other products to market. Work horses are large and are generally kept in sufficient number to do the necessary hauling and much or most of the plowing on nearly all of the farms.

The value of domestic animals constitutes nearly 10 per cent of the entire value of the farms in the two counties. The greater part of this value is in dairy cows, which number, as a rule, about 4 to 25 per farm. They are usually good grade animals, predominantly of Holstein blood. Purebred herds are kept by some of the large estate farmers.

Land is usually broken to an average depth of 6 inches with turning plows drawn by two, three, or four horses or by tractors. When tractors are used the land is broken deeper. After breaking the land the seed bed is prepared by the use of various kinds of drags, rollers, and harrows, depending upon the structure and nature of the land. When plowing is done in the fall usually the first implement used in the spring is the disk harrow. The two-horse drill is commonly used in seeding the small grains, and when commercial fertilizer is used it is applied with the seed. On some of the rougher, stonier lands the small grain is still sown by hand.

Corn is planted in several ways. Where the check-row system is used, three or four grains are put in a hill in rows 3 to 4 feet apart and so arranged that they can be tilled on all sides. In this case hand planters are used. The more common method is to use a corn planter and to drop the grains singly from 12 to 20 inches apart in rows 3 to 4 feet from each other. When the corn is to be used for ensilage it is usually planted closer together than when planted for grain. If it is to be fed green to stock during the growing season, it is usually sown by hand and is cut at a height of 2 or 3 feet. This crop is never cultivated, but corn for grain or ensilage receives several cultivations during the growing season. Corn is planted toward the end of May and cut early in October. After cutting it is shocked, allowed to dry, husked, and put in the crib. For ensilage the corn is cut when in the dough stage.

Wheat and rye are drilled about the middle of September. Timothy seed is sown with wheat or rye, and clover is broadcasted in the spring on the grain by the use of a wheelbarrow seeder. In years when the Hessian fly is feared, the farmers often do not drill their wheat until after a hard killing frost, thus causing a delay of two or three weeks beyond the usual seeding time. The grain is harvested in early July and stacked before threshing. Oats are seeded early in the spring and harvested in July or August. Buckwheat usually is sown where some other crop has failed, or on land which for some reason could not be planted to some other crop. It is sown any time before the middle of July.

The general farm crops are grown in rotation on nearly every farm. The common rotation consists of corn 1 year, oats 1 year, wheat or rye 1 year, and timothy and clover hay for 1, 2, or 3 years. There are a few modifications of this rotation. The practice of growing hay for only 1 year is becoming more popular, as most farmers are able to produce sufficient hay in this way for their farm stock.

The census report shows an expenditure for fertilizer in Somerset County in 1919 of $207,471 on 1,149 farms, and an expenditure in Morris County of $175,319 on 957 farms. This does not take into account the stable manure made on the farm. In general, the fertilization system is as follows: Stable manure is broadcasted on the sod land before the field is plowed for the planting of corn; a few farmers apply commercial fertilizer at the time of planting. The small grains are usually fertilized with 250 to 500 pounds per acre of a commercial fertilizer applied in the drill rows at the time of seeding. Wheat receives heavier applications than do the other small grains. Hay is top-dressed by a few farmers early in the spring with either manure or commercial fertilizer.

In former years, when labor and wood were both cheap and plentiful, lime was burned in many places throughout the area, and

its use on the land was very common.[3] Many of the kilns are still standing, but they are no longer in use, and only a few of the farmers are using sufficient lime to obtain the best results.

Some cow feed is purchased during the winter months by nearly all dairymen. The expenditure for feed in Morris County in 1919 was $709,574 on 1,059 farms reporting, and in Somerset County for the same year, $565,054 on 1,143 farms.

The greater part of the farm labor is performed by the farmer and his family. Extra help is necessary during harvest seasons, and on the larger farms some farm hands are hired by the year. Before 1914 the labor question was rather troublesome, but laborers usually could be obtained, as there were a number of young men in most localities who were willing to do harvest work. They were mostly native whites. Since 1914 the problem has become very serious, and many fields have been abandoned by the farmers because of the high wages. Farm laborers receive $4 to $5 a day, or $50 to $75 a month and board, but enough can not be obtained even at these wages.[4]

The farms in the area range in size from a few to several hundred acres. The smaller farms are on the sandier soils in the eastern part of the area, where truck farming is carried on extensively, and the largest farms are owned by wealthy business men. These extremes are not typical. The average general farm contains about 100 acres. According to the 1920 census, there are 1,333 farms in Morris County with an average size of 92.7 acres, of which 53.9 acres or 58.1 per cent is improved. In Somerset County, where there is a smaller percentage of rough land, there are 1,454 farms, with an average size of 94.2 acres, of which 77.7 acres, or 82.5 per cent, is improved land.

About 73 per cent of the farms in Morris and Somerset Counties are operated by the owners. Two systems are used on the rented farms—cash rent and share. There are nearly as many different variations in the share system as there are rented farms, for in each case there is an agreement in which the details are specified. Often the owner furnishes the land, buildings, and permanent fixtures, pays for half the fertilizer and seed, and receives half the grain. When the owner furnishes the cows he receives a certain proportion of the milk receipts and calves.

Land values vary considerably, depending mainly on location with reference to good roads and towns, character and nature of land, and improvements. In country-estate farming sections the price of land is often exceedingly high. Near the commuting sections small tracts of land are called farms and sold to city people at very high prices.

[3] Lime was burned not only in the sections where limestone was plentiful, but in many places the limestone was hauled to the farm or neighborhood where it was to be used, and then burned.

[4] These wages prevailed in 1919 when the field work was being done.

The general range is from $40 to $150 or $200 an acre. The average value of all farm property in Morris County, according to the 1920 census, is $15,284 per farm, of which 43.3 per cent is represented by the land. For Somerset County the average value of all farm property per farm is given as $15,145, of which 47.3 per cent is represented by the land.

SOILS.[5]

In the Bernardsville area there is a great variety of soils, owing to the fact that the area embraces parts of several well-recognized physiographic divisions, includes various rock formations, and represents several soil provinces of the United States. It includes some of the comparatively level country of the Coastal Plain, part of the Piedmont Plateau region, some Limestone valleys, Glacial drift areas, and a section of the Appalachian Mountains. The details of the profile or soil section vary greatly according to the parent material, and also to the topographic and drainage conditions.

Many of the soils in this area may be very broadly grouped as mature, well-drained soils which in their virgin state possess a profile having somewhat similar characteristics as regards color, number of horizons, texture and structure within the 3 or 4 foot section. This profile may be considered the standard for the climatic and vegetative province in which it occurs. It covers the forested region of the eastern part of the United States lying between southern New England and North Carolina, the boundaries, of course, being given in general terms.

The essential features of such a profile are as follows:

(1) Gray to dark-gray horizon, varying in thickness from a mere film to 2 inches. This includes the surface leaf mold and an admixture of organic matter with the soil.

(2) Light-brown to pale-yellow horizon. It has very little organic matter, but a texture similar to that of horizon No. 1. It possesses a silty or coarse, granular, usually called "nut" structure. It ranges in thickness from a few to 20 inches.

(3) Yellowish-brown to reddish-brown horizon which is heavier than the two above-mentioned horizons. It has a friable structure except when wet. It ranges in thickness from about 1 to 2 feet.

[5] The soils of the Bernardsville area join fairly well with the soils of the Belvidere area on the west. In a number of places along the boundary the soil areas apparently do not match, because in the Belvidere area certain stony and gravelly soils were mapped as separate types under distinctive colors, and in the Bernardsville area the same soils were mapped as stony or gravelly phases under the color of the loam types and distinguished from them by the use of symbols. The soils, therefore, are similar, but the methods of representing them are different. Some of the lesser areas do not join up, indicating the necessity of slight revisions here and there in the final map of the State.

The soils of the Bernardsville area likewise join fairly well with those of the Sussex area on the north. In most places where they fail to join the difference is more apparent than real. Land classed as Rough stony land in the Sussex area was mapped in greater detail in the Bernardsville area, and parts of it were separated as stony or gravelly phases of the Gloucester loam. Several small areas of Merrimac soils in the Bernardsville area join with areas of Hoosic soils in the Sussex area. These series both represent stratified glacial materials which differ slightly in origin.

(4) This horizon consists of slighty weathered parent material. The texture of this depends upon the character of the original material. If the parent material be heavy, this horizon is apt to be more plastic and tougher than No. 3. It is usually mottled or characterized by streaks and spots of brown, yellow, and gray, due to partial weathering, and is usually encountered at less than 40 inches.

In cultivated fields horizons 1 and 2 have been thoroughly mixed—that is, in the first few inches—and the color depends upon the state of cultivation and methods of handling the soils.

The well-drained, mature soils of the Bernardsville area belong in this group. They are the various types of the Sassafras, Gloucester, Chester, Hagerstown, Merrimac, Washington, Lansdale, Dunellen, Montalto, and Penn series.

Another group of soils in the Bernardsville area consists of the soils developed under conditions of excessive moisture. They have always been waterlogged or poorly drained and their present character is due primarily to that fact. They include the various members of the Whippany, Clyde, Elkton, Papakating, and Wehadkee series. The various soils consisting of recent deposits of alluvium, such as the soils of the Podunk, Codorus, Bermudian, and Birdsboro, are immature, having developed no profile of their own as soils. Their profiles consist of the various strata laid down at the time of their deposition. Their profile is therefore a geological and not a soil profile.

The Croton soils are characterized by the heavy plastic subsoil and the highly eluviated soil or surface horizon characteristic of such soils.

All of the soils of the Bernardsville area, except small areas of Muck, Clyde, and Papakating, are light in color; that is, they range from gray to brown in the surface portion. The mature, well-drained soils are more uniformly brown in color. All the soils are being subjected to leaching and all have been leached and are permanently kept leached of most of their readily soluble material. The concentration of mineral matter in the soil water, so long as it depends on the first, second, and third horizons only for its source of mineral material, tends to become constantly more and more dilute, other things remaining equal. This leaching, together with better drainage oxidation, and other changes taking place in the soil, has a general tendency toward a simplification of the soils rather than an increase in their complexity. In other words, these agencies are working toward a uniform soil section or profile.

With the exception of the Muck and Clyde soils, the soils of the Bernardsville area are, for the most part, low in organic matter. This is accounted for by reason of the area being well drained, and, until reclaimed for agricultural purposes, covered with forest. The

small amount of organic matter, or vegetable mold, in the forested areas is only a superficial covering, and when the land is cleared and cultivated for a few years this is dissipated largely or is so thoroughly mixed with the soil that it does not appreciably influence the color of the surface soils.

There is no free deposit of carbonate of lime in any of the soils of the area, even where the original rocks contained lime, for with the heavy rainfall, leaching, and good drainage, this and other soluble materials have not accumulated as they normally would in the drier regions of the United States.

In classifying the soils of the Bernardsville area, there is found to exist a close relationship between the various soils and the geological formations from which they are derived.[6]

The principal rock formations of the area consist of gneiss, limestone, shale, sandstones and conglomerates, diabase and basalt, schist, slate, and argillite. The Watchung Mountains are underlain by basalt, while the Sourland Mountain and the ridge just west of Oldwick (New Germantown) have diabase beneath them. The crystalline rocks consist of gneiss, basalt, and diabase. Most of the soils of the area are underlain at varying depths by solid rock. The limestone and shale are of minor importance, while the Triassic sandstone, conglomerate, and argillite are the most important of the sedimentary rocks and underlie the Piedmont Plateau region.

It appears that two ice sheets invaded the northern and eastern parts of the Bernardsville area. The earliest of these, the Jerseyan, deposited a mantle of drift, but no terminal moraine is now apparent. In many places the drift has been entirely removed. Gravel, cobblestones, and bowlders are in evidence. The later, the Wisconsin, left a terminal moraine, which crosses the area in a large sweeping curve extending along the northern border east to Denville and thence southerly in the vicinity of Morristown, Summit, Plainfield, and Metuchen. It varies from a fraction of a mile to about 3 miles in width. The drift left by this glaciation consists of material picked up, transported, partly pulverized, and later deposited or placed by the moving ice. Many lakes were formed by the accumulation of ice and rock débris in the channels of streams; the largest was Lake Passaic. In the low part of these old beds organic matter has accumulated and mixed with mineral matter, resulting in areas of Muck. With the exception of Hopatcong, Budd, Silver, White Meadow, Estline, and Mountain Lakes, the glacial lakes have either been drained or filled in.

The soils are grouped into series on the basis of color, structure, origin of material, and drainage conditions. The soil types, the units of classification, are separated on the basis of texture of the

[6] For detailed information regarding the geology of the area, consult geological map of New Jersey.

material. In the series descriptions are given the source of soil material and processes by which the soils have been formed.

The glacial soils include all of the types mapped in the area that are derived from unstratified drift or till, including deposits of both the Jerseyan and Wisconsin ice sheets. These types are grouped into three soil series—Washington, Gloucester, and Wethersfield.

The types of the Washington series are characterized by brown surface soils and a reddish-yellow or light-red, moderately friable subsoil. Angular fragments and rounded gravel and cobblestones of gneiss, quartzite, chert, and other siliceous rocks are present in soil and subsoil. The parent material consists of old glacial drift remaining here and there south of the moraine of the later drift (Wisconsin), most of it occurring in the valleys and over the flatter areas underlain by gneiss. Some of it is found over the Triassic shale and sandstone and some over basalt and gneiss. Probably limestone was present in the material, but evidence of such material has been removed by decay and leaching.

The types of the Gloucester series have light-brown or grayish-brown surface soils and a yellow and yellowish-brown friable subsoil. They are derived from glacial drift which consists for the most part of material derived from gneiss and trap rock. Large quantities of grit are present throughout the soil and subsoil. The rounded rock fragments consist of gneiss, trap rock, quartzite, sandstone, and quartz. Huge bowlders are present in many places. The Gloucester loam, with two phases, is mapped in the area.

The types of the Wethersfield series are brown or chocolate brown in the surface soil and Indian red in the subsoil. They are derived from glacial till composed largely of material of shale and sandstone of Triassic age. The foreign material consists of trap rock, gneiss, and quartzite, gravel, cobblestones, and bowlders of these rocks being present in the soil and subsoil. These soils occur on typical morainic topography (very hummocky). The gravelly fine sandy loam and the gravelly loam types are mapped.

Glacial Lake and River Terrace soils embrace the soils that are derived from stratified glacial deposits, including those formed by streams and those formed in the beds and along the shores of old lakes. The Clyde and Whippany series and Muck are developed in the wetter parts of the old lake beds. They differ mainly in the content of organic matter. The Merrimac and Dunellen are well-drained soils of this group.

Muck consists of decomposed organic matter mixed with a small amount of mineral soil material. It is very swampy and wet.

The Clyde series consists of types with dark-brown or black surface soils and mottled gray and yellow clay subsoil, with gray or greenish-gray sand in places. These are poorly drained, swampy soils.

The Whippany series is characterized by the gray to light grayish brown color of the surface soils, the yellow or mottled gray and yellow color and generally plastic nature of the upper subsoils, and the presence of a tough, impervious clay pan in the lower subsoils, normally of a dull Indian red color, mottled in places with yellow or gray. These soils occupy flats into which materials from glacial uplands have been washed, and to some extent from the residual soils, such as the Penn and Chester. The greater part of this material appears to have accumulated in the low places formerly occupied by old glacial lakes. The drainage is very poor.

The types of the Merrimac series have brown to light-brown surface soils, with a friable, brownish-yellow subsoil and normally a lower stratum of yellow, brown, or reddish, more friable material. They owe their origin to the weathering of material placed by glacial waters or by the reworking of glacial material by streams. Most of the material has been derived from the regional crystalline rocks, consisting mostly of gray and white gneiss and dark fine-grained basalt. The soils have a flat to sloping topography and are well drained.

The types of the Dunellen series are characterized by the dark reddish-brown color of the surface soils, and by the lighter reddish-brown to Indian-red color and friable structure of the subsoil. The lower subsoil is almost invariably coarser textured, containing more medium and coarse sand and fine gravel than the upper subsoil. These soils are derived from a stratified glacial material of outwash plains lying south of the terminal moraine, or from stratified drift within the glaciated regions. Locally, some of the material is derived from unconsolidated material of the Coastal Plain region, but this has been included with these soils because most of the material is of Triassic origin and the areas are not extensive. Most of the material has the color of the Indian-red Triassic rocks from which it has been derived. The surface is characteristically flat and the drainage is good.

The unglaciated Highlands soils, or those of the Appalachian, of the Bernardsville area have been derived by weathering in place of gneiss rock. The Chester series includes the soils of this province.[7]

The types of the Chester series are characterized by gritty, light-brown to grayish-brown surface soils, and a yellow, gritty, friable subsoil. Fragments of the gray and white granitoid gneiss of pre-Cambrian age are found on the surface and throughout the soil and subsoil. The Chester soils differ from the Gloucester soils chiefly in mode of formation.

[7] The Chester soils rightly belong in the Piedmont, while the corresponding Appalachian Mountain soils are called Ashe. In the Bernardsville area it was not deemed necessary to separate the two, because of the relatively slight difference in elevation between the northern part of the Piedmont and the country occupied by the soils mapped as Chester. The Ashe soils properly occur at considerably higher elevations than the Piedmont soils, and it is possible the climatic environment has effected some differences in the soils of the two regions.

The Limestone Valley soils have been derived from the Kittatinny limestone. In the weathering of this limestone most of the bulk of the original rock is carried away in solution, leaving the impurities in the original rock to make up the main part of the soil. The bedrock is from 3 to 8 feet below the surface. The soils have been correlated with the Hagerstown series, which includes types with brown, mellow surface soils, and a brownish-red or brownish-yellow friable clay subsoil.

The soils of the Piedmont Plateau region include the Montalto, Watchung, Penn, Lansdale, and Croton series.

The Montalto soils are derived from the weathering of the basalt and diabase of the Watchung and Sourland Mountains. The surface soils are brown and the subsoil is reddish brown or reddish yellow.

The Watchung series consists of types having grayish-brown or gray surface soils and a pale-yellow or mottled gray and yellow subsoil, with a tough plastic clay-pan layer in the lower part. This layer is a dull-chocolate or brownish color, mottled with gray or bluish gray and yellow. The soils are derived from material coming from trap rocks and differ from the Montalto soils with which they are associated in being poorly drained.

The Penn series include Indian-red soils and Indian-red subsoils which have been derived from the underlying Indian-red shale, sandstones, and conglomerates of Triassic age. The shale loam, gravelly loam, and silt loam types are mapped.

The Lansdale series includes types with brown or grayish-brown surface soils and a yellow or yellowish-brown moderately friable subsoil. The material has been derived from the underlying gray shales and sandstone, or dark argillite of Triassic age. The shale loam, gravelly loam, and silt loam types are mapped.

The types of the Croton series have grayish to brownish-gray or ashy-gray soils, and a mottled yellow and gray clay upper subsoil, below which an impervious, heavy, compact hardpan layer, mottled yellow, brown, and bluish gray, is encountered. The characteristics of these soils are due to some development favoring the formation of a hardpan layer in the subsoil. They are formed of material derived from any or all of the sedimentary Triassic rocks, including especially argillite. The silt loam type alone is mapped in the present area.

The Coastal Plain soils of the Bernardsville area are derived from unconsolidated sandy clays, heavy clays, sands, and gravels. In addition to the true Coastal Plain part of the area in the southeast corner, the adjoining area underlain by the Triassic rocks is covered in places with deposits of similar material, and such areas have been included with the Coastal Plain region. The Sassafras and Elkton series are represented.

The Sassafras series includes types with brown or grayish-brown surface soils and a reddish-yellow, reddish-brown, or orange-colored friable subsoil, which is typically coarser in texture and less compact in the lower part. Small whitish quartz gravel is found in many places on the surface or in the soil or subsoil, or from the surface down. The Sassafras loam, sandy loam, and sand are mapped.

The Elkton series is characterized by gray surface soils and a light-gray or mottled light-gray or bluish-gray and yellow subsoil. The material corresponds in origin with that of the Sassafras. Poor drainage as a result of the flat or depressed position has caused the grayish and mottled colors characteristic of the series.

River Flood Plain soils include the soils that have been transported and deposited by streams. These are of two classes: (1) Those occupying low-lying or first-bottom positions along the water courses, where they are subject to periodical overflow, and (2) the terrace or second-bottom soils, occupying benches which formerly were the first bottoms of the streams, but which now represent second or third bottoms, the stream channels having been cut deeper to form new and lower flood plains and to leave the old bottoms above overflow, or at least above ordinary overflow. On second bottoms were mapped the Birdsboro and Roanoke series, and on first bottoms the Papakating, Podunk, Codorus, Wehadkee, and Bermudian series.

The Birdsboro series includes brown to reddish-brown or dark reddish brown soils developed on alluvial deposits, representing reworked material coming mainly from the Penn soils. These are well-drained terrace soils occupying second and third bottoms.

The types of the Roanoke series are characterized by gray or mottled surface soils and a mottled gray or bluish-gray and yellow subsoil, which passes into a tough, impervious clay pan or hardpan. They represent poorly drained second-bottom soils, consisting of alluvial material which, in part at least, has been derived from the Chester and Montalto soils. They are the terrace equivalent of the Wehadkee soils.

The Papakating series is characterized by very dark or black surface soils which are mucky in places, and by a gray, blue, or mottled subsoil. These soils occur along streams which flow from or through the glacial uplands. They differ from the Podunk soils in being swampy and very poorly drained.

The Podunk series includes types with dark-brown or brown surface soils and a yellow or brown friable subsoil. They are first-bottom soils consisting of alluvial wash coming principally from the Gloucester soils. They are fairly well drained.

The types of the Codorus series have grayish-brown or brown surface soils and a yellow or brown friable subsoil. They occupy first-bottom positions along streams flowing through or from the ungla-

ciated mountain sections of the area, and represent wash chiefly from the Chester and Montalto soils. Mica flakes are present in both soil and subsoil.

The Wehadkee series consists of types with gray surface soils and a mottled gray or bluish-gray and yellow subsoil. In places the lower subsoil is a dull-reddish, tough, plastic, rather impervious clay. These soils are poorly drained.

The Bermudian series includes Indian-red to reddish-brown first-bottom soils composed largely of wash from the Penn soils. They are characteristically friable and are well drained between overflows.

In the chapters following the characteristics of the various types and phases are described more in detail, and their relation to agriculture is brought out.

The table below gives the actual and relative extent of the soils mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Chester loam	6,400		Clyde loam	6,848	1.5
Gravelly phase	37,184	15.0	Penn gravelly loam	6,784	1.5
Stony phase	25,984		Sassafras loam	6,720	1.4
Penn silt loam	66,432	14.3	Montalto silt loam	6,656	1.4
Gloucester loam	2,048		Croton silt loam	6,016	1.3
Stony phase	25,024	9.6	Podunk loam	5,376	1.1
Gravelly phase	17,856		Papakating silt loam	5,248	1.1
Penn shale loam	26,432	5.7	Merrimac fine sandy loam	4,352	.9
Whippany silty clay loam	22,144	4.8	Birdsboro silt loam	3,228	.7
Washington loam	13,184	4.4	Tidal marsh	2,880	.6
Gravelly phase	7,232		Watchung silty clay loam	2,624	.6
Bermudian silt loam	18,916	4.1	Lansdale shale loam	2,112	.4
Montalto stony loam	17,792	3.7	Lansdale gravelly loam	1,920	.4
Wethersfield gravelly loam	17,024	3.7	Lansdale silt loam	1,792	.4
Montalto gravelly loam	16,192	3.5	Roanoke silty clay loam	1,344	.3
Dunellen sandy loam	11,712	2.5	Papakating *silty* clay loam	1,280	.3
Dunellen loam	11,072	2.4	Wethersfield gravelly fine sandy loam	1,280	.3
Merrimac loam	3,584	2.4	Hagerstown silt loam	1,216	.3
Gravelly phase	7,424		Sassafras sandy loam	1,024	.2
Codorus loam	10,880	2.4	Elkton clay loam	832	.2
Merrimac sandy loam	6,208	2.3	Sassafras sand	512	.1
Gravelly phase	4,480		Wehadkee *silty* clay loam	512	.1
Muck	7,232		Clay pits	192	.1
Intermediate phase	1,856	2.3			
Shallow phase	1,216				
Rough stony land	7,744	1.7	Total	464,000	

WASHINGTON LOAM.

The Washington loam is a brown mellow loam grading at about 8 to 10 inches into yellowish-brown, friable silty clay loam, which passes into reddish-brown, friable silty clay containing in places sufficient Indian-red material in the lower part of the 3-foot profile to give a

reddish cast. Both soil and the subsoil contain considerable grit. The texture of the type as mapped ranges in places to a silt loam. In a number of places areas of Washington silt loam are included. An attempt was made to separate the loam and silt loam, but it was found impracticable, owing to the fact that in so many places the grit is so noticeable that the soil does not have the texture of silt loam, even though much of the fine material consists of silt. On the mountains where it was mapped over the gneiss it is unquestionably a loam in texture, but where mapped over the red shales and in the valleys it is not everywhere a loam. Nearly everywhere there are present noticeable quantities of gravel and cobblestones of the same kind as found on the gravelly phase, described below. The thickness of the glacial material which gives rise to the Washington loam varies from about 18 or 20 inches to many feet. Much of the soil mapped over the red shale formation in the southwestern part of the area is, comparatively speaking, rather thin. In the areas mapped in the vicinity of White House and Readington, north of Somerville, and in several other places in this part of the area, the red shale soil material is encountered locally at depths varying from about 18 to 36 inches. In many of these places the lower subsoil appears to be made up largely of the red shale soil material (Penn), and in other places such material appears to have had a marked influence upon the lower subsoil.

The Washington loam occurs in large tracts in many places in the western half of the area, south of the moraine. Large and important bodies lie in the gneiss hills south of Mine Hill, at the lower end of Budd Lake, east of Dover, and north of Mendham. Other tracts occur in the valley in which Flanders and Bartley are situated, northwest of Mendham, near Bernardsville, west of Liberty Corner, and in the southwestern part of the county. The type ranges in elevation from less than 200 to more than 1,000 feet above sea level. The topography in general is gently rolling and the drainage is very good.

Nearly all of the type is cleared of its original forest, consisting of oaks, chestnut, elm, walnut, hickory, sassafras, and maple, and is under cultivation. Corn, oats, wheat, rye, and hay, mainly red clover and timothy, are the principal crops. Buckwheat, alfalfa, potatoes, and truck crops are grown locally. In some places there are large commercial orchards of peaches, as well as a few of apples, pears, and plums. Until a few years ago this type, like many of the other types in this part of the State, was considered an excellent peach soil, but since the large peach orchards in southern New Jersey have come into bearing, this northerly section has fallen into a place of secondary importance, presumably because the sandier soils and moderate climate of southern New Jersey meet better the requirements of

this fruit. Another cause of the decline has been the failure of some to adopt modern methods of orchard management.

Dairying is of first importance on most of the farms. The milk is sold to the city markets as whole milk. A few farmers have special customers in near-by towns whom they supply with butter, and there are a few cheese and butter factories in the area. A few horses and mules are raised, but most of the horses are purchased from western markets. Hogs and poultry products are of minor importance on most of the farms, though a larger revenue is obtained from chickens than is usually realized by most of the farmers. Fruit and vegetables of all kinds are produced, usually in sufficient quantities to supply the home.

Corn yields range from about 35 to 80 bushels per acre, averaging about 50 bushels. An increasing proportion of the crop is being put into silos for winter feeding. Oats yield from 35 to 45 or even 50 bushels per acre, and wheat yields about 18 to 25 bushels. Hay yields from 1 to 2 tons, averaging about 1½ tons per acre.

Crops are grown in rotation. Up to a few years ago a five-year rotation of corn, oats, wheat, or rye, followed by timothy and clover for two years, was the most common, but since the market for surplus hay in the cities has fallen off, owing to the increasing number of automobiles and trucks, many of the farmers consider it best to allow grass to occupy the land only one year. In this way they produce enough on most farms to feed their own stock, but have little surplus for sale. Good, thorough tillage methods are practiced generally. Two-horse and three-horse plows, cultivators, harrows, reapers and binders, and corn harvesters are used. The smaller tractors recently have become very popular. The stable manure made on the farm is applied to the sod as a rule before turning under for corn, and small grains are fertilized at seeding time with about 150 to 500 pounds of commercial fertilizer low in nitrogen and high in phosphoric acid. Wheat as a rule receives more fertilizer than oats. In order to obtain the best stands of clover, farmers say they have to use some form of lime, but many of them neglect to apply it.

The value of land of this type for farming formerly ranged between $50 and $125 an acre, depending upon the general condition of the soil, the improvements, and the location. In recent years of general inflation of land values it has been held at higher figures.

Washington loam, gravelly phase.[8]—The Washington loam, gravelly phase, consists of a brown gritty loam about 8 to 10 inches deep, overlying yellow gritty clay, which passes into a reddish-yellow,

[8] This soil is really a distinct soil type—a gravelly loam—but in this area it is mapped as a gravelly phase of the Washington loam in order to reduce as far as practicable the number of colors on the soil map.

friable gritty clay. In many places the subsoil is reddish yellow even in the upper part. In a few places near the Penn soils the lower subsoil has an Indian-red color, showing that in such places this subsoil material is derived mainly from the underlying shales of Triassic age. On the surface and through the soil and subsoil there is an abundance of rounded gravel and cobblestones. These stones consists of gneiss, chert, quartzite, sandstone, and other hard rocks. Many of the chert fragments show holes representing former limestone fragments which by weathering processes have been completely dissolved and removed. Many of the gneiss fragments have disintegrated and it is probable that this material gives rise to the gritty particles commonly present in the lower subsoil.

The Washington loam, gravelly phase, occurs largely on the flatter parts of the gneissic hills and mountains, where it is associated with the typical Washington loam and the Chester soils. The largest areas were mapped on Mine Hill, south of Dover, about a mile west of Ledgewood, near Franklin, south of Naughright, and near Flanders. It has a gently rolling to sloping topography and good drainage.

This soil is nearly all cleared and is used extensively for farming. It is handled in the same way as the typical Washington loam, and the yields usually are as good. The only agricultural difference is that the slightly steeper or more rolling topography of the phase and its higher content of gravel make it more difficult to till.

GLOUCESTER LOAM.

The surface soil of the Gloucester loam is a brown loam about 8 to 10 inches deep. The subsoil is a light-brown to yellowish-brown clay loam, which grades beneath into a yellow or brownish-yellow clay or sandy clay loam. In places, as near Summit, the soil is a brown loam underlain at about 10 inches by yellowish-brown loam. A reddish cast appears here and there in the lower subsoil. Pockets of sand and gravel occur in places, but the material is not stratified, and such areas represent local inclusions too small to be satisfactorily separated. The material contains gravel and cobblestones of gneiss and trap rock, together with some quartz and sandstone. In places it appears to have been derived almost entirely from trap rock.

The Gloucester loam is found at somewhat lower levels and has a less rolling topography than the stony and gravelly phases. It is not an extensive soil. The largest and most important bodies are those near Hanover Neck, Hanover, Florham Park, and east of Boonton. It occurs in numerous places in the terminal moraine as small isolated patches. It is naturally well drained.

This type is cleared and most of it is farmed. It is considered an excellent soil for the general farm crops of the region. It is easier to till than the stony or the gravelly phase, and therefore is considered more valuable.

Gloucester loam, stony phase.[9]—The Gloucester loam, stony phase, is a light-brown to brown gritty loam, about 3 to 6 inches deep, overlying yellowish-brown, gritty loam, which passes into yellow very gritty clay loam at an average depth of about 10 inches. The grit consists for the most part of gneiss particles, but is in part of feldspar. In places mica flakes are noticeable. In some areas the subsoil has a slightly reddish color, but this is not typical. There is an abundance of angular and partly rounded gravel, cobbles, and huge bowlders of gneiss through the soil and subsoil and over the surface, together with some fragments of trap rock, reddish sandstone, and quartzite. This phase differs from the gravelly phase of the Gloucester loam, mainly in the larger amount of large stone fragments, cobblestones, and bowlders present.

In some areas mapped south of Dover and elsewhere the soil differs in that it contains some material apparently derived from deposits of the old Jerseyan ice sheet; but these areas have been included with the Gloucester because of similarity in character of material.

This phase is an extensive soil in the northern and northwestern parts of the area. It has a characteristic morainic topography, varying from hummocky and gently sloping to very hilly and mountainous. It has a steeper and rougher surface than the Gloucester loam, gravelly phase. It occurs at elevations ranging from about 500 to over 1,000 feet above sea level. Drainage is good but not excessive.

Nearly all of the area of this phase is covered with oak, chestnut (blight-killed), hickory, birch, tulip poplar, ash, basswood, elm, and in places hemlock. Ferns are numerous in the densely wooded areas.

The principal use of this soil at present is for forestry and pasture. Areas from which the timber and stones have been removed sufficiently for cultivation have been classed with the gravelly phase. A considerable part of this land as it now stands is capable of being so cleared and would make fine fruit land. A large part of it, however, is giving better returns at present in forest than it would in cultivation, for the slopes are too steep in most places for successful cultivation and should not be cleared.

Gloucester loam, gravelly phase.[10]—The Gloucester loam, gravelly phase, is very similar to the Gloucester loam, stony phase, except that it contains fewer stones, and most of these have been removed and placed in piles in the fence corners and along the edges of fields. These are for the most part of gneiss. Regardless of the fact that

[9] This soil is really a distinct soil type, the Gloucester stony loam, but in this area it is mapped as a stony phase of the Gloucester loam, in order to reduce as far as possible the number of colors on the soil map.

[10] This soil is really a distinct type, the Gloucester gravelly loam, but in this area it is mapped as a gravelly phase of the Gloucester loam, in order to reduce as far as practicable the number of colors on the soil map.

large quantities of stone have been removed in most places, the content is still large. The surface soil differs from that of the stony phase in that the brown upper layer is deeper, being usually 6 to 10 inches deep. This is due to the fact that it has been cultivated and reworked into a deeper lower layer by the plowing in of vegetable matter, whereas the stony soil is not cultivated at all. A considerable part of the fine earth contains gritty material in such quantities that it seems upon superficial examination much like a sandy loam.

Some hummocks of sandy loam have been included in the mapping because of their small extent. The largest and most important areas of this sandy loam are near Budd Lake and about one-half mile south of Chatham. In the general vicinity of Summit and Short Hills (lying just outside the area on the east) there appears to be a larger proportion of sandstone and shale material mixed with this soil, and although it is not as red as the Wethersfield soils, it has here a decidedly reddish cast in the subsoil. There are included patches of Gloucester stony loam and Wethersfield gravelly sandy loam.

The Gloucester loam, gravelly phase, is associated with the Gloucester loam, stony phase. The largest tracts are mapped in extensive belts near Morristown, Chatham, Summit, Morris Plains, and Boonton, where it occurs mainly on the ridges and higher positions. It is well drained.

Most of this soil has been cleared of stones and timber and is capable of being cultivated. Part of it is used for corn, oats, wheat, rye, timothy, and clover. Near the smaller towns in the eastern part of the area it is used for tomatoes, potatoes, cabbage, and other market-garden crops. Dairying is an important industry on much of this soil.

The crop yields are good, though the soil is considered rather difficult to till, owing to its stoniness and in some cases to its rather steep topography. Much of this soil is not devoted to agriculture at all, being used instead for country or suburban homes. Most of it lies within 20 or 25 miles of New York City, and occurring in the Highlands in a section where there is a large acreage of the poorly drained lower lying Whippany and Clyde soils, it very naturally has been preferred for building sites.

WETHERSFIELD GRAVELLY FINE SANDY LOAM.

The surface soil of the Wethersfield gravelly fine sandy loam is a brown to chocolate-brown or dark reddish brown fine sandy loam about 8 to 10 inches deep. The subsoil is Indian red in color and ranges in texture from fine sandy loam to sandy clay. There are

some small patches of loamy sand and fine sand included with the type as mapped, as in the area about 1½ miles northeast of Westfield. The gravel consists of reddish sandstone and shale, together with some gneiss, trap rock, and quartzite. This soil appears to contain more material derived from trap rocks than does the Wethersfield gravelly loam.

The type is developed on a terminal moraine and has a rolling hummocky topography. It occurs chiefly in the vicinity of Summit. It is well drained.

Much of the type is covered with forest of oaks, hickory, and dead chestnut. It is not extensive, neither is it important in the agriculture of the area, since most of it is either being used as building sites or held for sale for that purpose. Where farmed it is used for the same crops as the Wethersfield gravelly loam, and the yields are about the same.

WETHERSFIELD GRAVELLY LOAM.

The Wethersfield gravelly loam is an Indian-red to dark reddish brown loam, about 6 to 10 inches deep, overlying Indian-red friable clay loam to clay, which becomes stiffer and of a deeper chocolate red color at depths of about 30 inches. In many places it contains much grit, particularly in the subsoil. It also contains large quantities of reddish sandstone gravel and cobblestones and shale fragments, and in most places some trap rock and gneiss gravel as well. In some locations, as in the area on the high ridge about 2 miles north of Westfield, there are many large bowlders of trap rock and gneiss. Such stony areas are shown on the map by stone symbols. At Mountainside, east of Plainfield, and elsewhere the tops and the lower slopes of the ridges consist of sandy loam and fine sandy loam, but these have been included with this type owing to their small acreage. In small local depressions the lower subsoil is mottled gray and yellow, but these areas are small and few in number.

The type has been mapped on the moraines along the eastern border of the area beginning just south of Summit and extending to Metuchen. It has a hummocky, ridgy, or rolling topography. Except in the small depressions it is well drained.

The greater part of this type has been cleared of the original hardwood forest and is either under cultivation or in use for building sites. The town of Westfield is located on it, as also are many smaller towns. Where farmed the usual farm crops of corn, oats, wheat, rye, and hay are grown. Truck or market-garden crops, such as tomatoes, cabbage, onions, and Irish potatoes, are grown to a considerable extent. Several large dairy farms are on the type. The yields of crops are good, and the fertilizer and tillage methods are similar to

those practiced on the other well-drained loam soils of the area. Its value at the present time ranges from about $80 to $125 an acre in the strictly farming districts, but much of the land lying within the suburban zone of New York City is held at much higher prices.

CLYDE LOAM.

The Clyde loam consists of a dark-colored or black mucky loam to silty loam, underlain at depths varying from about 7 to 30 inches, usually at about 10 inches, by a gray, black, or mottled grayish and yellowish or brownish heavy silty clay, which becomes stiffer below. In places the lower subsoil is a gray or greenish-gray loamy sand or sand. This type, as mapped, contains many variations. In places the clay layer is not present, the black surface soil being underlain by gray or mottled gray and yellow sand or loamy sand. In other places the clay is so stiff that one can hardly bore into it, and often the sand layer is not reached within the 3-foot section. Some areas consist of dark-brown to black loam, underlain by mottled gray, yellow, and rusty-brown clay, which in places has a clay-pan layer of yellowish-brown and rusty-brown color containing some dark concretionary material at depths of about 2 feet. Some of the areas consist of brown, dark-gray, or light-gray silt loam in the surface, with mottled yellow and gray silty clay subsoil. An attempt was made to separate the lighter gray patches of soil from the typical, but it was found impossible to do so on the scale of map used. In a number of included areas the soil contains a great quantity of gneiss cobblestones and large bowlders.

The type is associated in occurrence with the glacial-till and glacial-outwash soils. Some of the areas are associated with the Washington soils. There are no large tracts of the Clyde loam, but many small though important areas. The type has been mapped in depressions here and there throughout the northern and eastern parts of the Bernardsville area. Some of it occurs on wet seepage slopes. It is a very poorly drained soil.

A large part of the type is still covered with its native growth, which consists of two kinds: (1) On the open marshlike places there are but few trees and an abundance of reeds, sweet flag or calamus, and other water-loving plants and grasses; and (2) areas with oak, black gum, maple, basswood, birch, hazel, and alder. Where cleared it is used chiefly for pasturing dairy cows during dry periods. In a few places, where the drainage has been improved artificially, good yields of corn, timothy, cabbage, onions, strawberries, and other crops are obtained.

Liberal applications of lime after the installation of efficient drains probably would prove profitable.

WHIPPANY SILTY CLAY LOAM.

The typical Whippany silty clay loam consists of gray or brownish-gray to grayish-brown silty clay loam about 6 to 10 inches deep, overlying mottled yellow and gray or bluish-gray heavy, plastic clay, which passes at depths ranging from about 24 to 30 inches into a tough, dull Indian-red clay pan which is faintly mottled in places with blue and yellow. The clay pan is so tough and stiff that it is nearly impossible to bore into it more than an inch or two without pulling the auger out. It is usually dry even when the surface is saturated with water. The higher parts are not so poorly drained, and differ from the typical soil in consisting of a gray-brown or light-brown silt loam to a depth of about 8 inches, underlain by mottled yellow and gray silty clay which becomes stiffer with depth. The clay pan is reached at about the same depth as in the typical soil. In places, as north of Hanover Neck and south of Whippany, this variation is located on high, flat areas or on poorly drained hillsides. In some included areas the lower subsoil is sandy, but these areas are very small and lie near areas of Merrimac sandy loam or fine sandy loam. Northeast of Stelton and at Clyde station the areas mapped as Whippany silty clay loam consist of material derived from deposits of the Coastal Plain. These have the same general characteristics as the typical soil, except that the surface soil is a silt loam. Here some Pensauken gravel is seen. In other sections some trap rock, gneiss, sandstone, and even shale gravel and cobblestones are not uncommon.

The Whippany silty clay loam typically is a glacial-lake soil and has been mapped in the poorly drained parts of the old Glacial Lake Passaic in the northeastern quarter of the area, as well as in poorly drained places in the southeastern part, where either old lakes or large glacial streams once existed. The largest areas were mapped south and east of the reservoir near Boonton, near Hanover Neck, Hanover, Whippany, Chatham, Madison, in the Great Swamp near Pleasant Plains, south of Stirling along the flats bordering the bottoms of the Passaic River, and in smaller bodies in this same general region. It is a low-lying swampy soil, much of it being under water during parts of the year. Some better-drained areas occur on higher elevations along the sides of hills or even mountains, but all areas are everywhere poorly drained.

The type is covered for the most part with pin oak, elm, hickory, maple, birch, alder, and hazel. In many open places a marsh type of vegetation is found. The cleared areas are used chiefly for pasture. In places where the drainage is naturally better or where it has been improved artificially, corn, hay, and truck crops, such as cabbage and tomatoes, are produced. In most cases these crops did not appear, at the time of the survey, to be thriving.

Land of this type in or near the suburban districts of New York is held at rather high prices; elsewhere it is a soil of moderate value.

The table below gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the type:

Mechanical analyses of Whippany silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170943	Soil	0.0	0.0	0.8	1.3	5.5	61.4	[1] 31.0
170944	Subsurface	.0	3.2	1.0	2.6	5.1	62.8	27.1
170944½	Subsoil	.0	.0	1.2	1.8	2.8	65.0	29.0

[1] The material stated as "clay" is probably in part organic matter.

MERRIMAC SANDY LOAM.

The Merrimac sandy loam consists of brown sandy loam, underlain at about 8 to 12 inches by yellow or yellowish-brown sandy loam, which becomes lighter in texture below, grading in places into yellowish-brown light loamy sand or sand at about 30 inches. The subsoil has a reddish cast in some areas. In places small areas of sand, loamy sand, and coarse loamy sand are included with the type. Some areas included contain so much gravel that they really constitute a gravelly phase of the type, but some of these are not large enough to be shown on the map by the use of the gravel symbol. Near Green Village and in a few other places in the same general locality the areas mapped as sandy loam contain a number of small depressions of Muck, Clyde loam, and Whippany silt loam.

The Merrimac sandy loam is developed on stratified wash from glacial till, derived largely from gneiss rocks. It occurs on the big outwash plains at Succasunna and along many of the streams flowing through or from the glacial sections in the northern and east-central parts of the area, as along the flats of the Rockaway, Whippany, and Passaic Rivers. It also occurs as slight elevations in the old glacial lake bottoms, as in the areas near Green Village and Hanover. Typically it has a flat to gently rolling topography. Except for the depressions noted above, it is well drained.

The Merrimac sandy loam is an extensive soil and is important in the agriculture of the area. It is nearly all cleared, and much of it is farmed. The general farm crops of corn, oats, wheat, rye, and hay are of first importance. In many places, especially in the eastern areas, truck crops are very important. Irish potatoes, cabbage, sweet corn, tomatoes, peas, cucumbers, eggplant, and beans are among the truck crops grown. In other places dairying predominates. Near Morristown and in some other places horses, dairy cattle, hogs, and poultry are raised.

The yields of the general farm crops, as well as of vegetables, are very good. The fertilization and tillage methods are the same as those described in the chapter on agriculture. The truck crops are fertilized more highly than the general farm crops. Many of the truckers or market gardeners apply about 8 tons of stable manure per acre. When commercial fertilizers are used, these crops receive 500 to 600 pounds per acre. Many use both manure and fertilizer. Without manure and fertilizer heavy yields are not expected.

The value of this land is difficult to estimate, for much of it is either located near rather large industrial towns or in the commuting sections, and as a result the land often brings a very high price. In places it can be purchased at $75 to $125 an acre.

The productiveness of this soil would be improved by growing and occasionally plowing under such humus-supplying crops as rye, vetch, and crimson clover.

Merrimac sandy loam, gravelly phase.[11]—The Merrimac sandy loam, gravelly phase, is brown sandy loam passing beneath into yellowish-brown or light-brown sandy loam with sandy strata below, which are encountered in places within the 3-foot section. Both soil and subsoil contain waterworn gravel, consisting for the most part of gneiss and trap rock, along with some sandstone, quartz, and quartzite. Some of the sandstone is Indian-red and of Triassic origin, and in places small areas of Dunellen gravelly sandy loam have been included. There are also some included areas of sand. In places the subsoil is slightly reddish.

The phase is associated with the typical Merrimac sandy loam, but much of it occurs on higher knobs, ridges, or hills. It is well drained. In places where the gravel deposits are exceptionally deep, crops sometimes suffer in dry seasons from lack of moisture.

The phase is practically all cleared and is used in the same way as the Merrimac sandy loam. Some very fine orchards are established on it. It seems to be better suited to fruit, especially peaches, than the typical sandy loam, probably because it occupies a higher position and has better air drainage and greater freedom from unseasonable frosts. There is otherwise very little difference in the value of the typical soil and the gravelly phase for farming purposes. City residents, who often purchase tracts of these soils, seem to prefer the more hilly land, and for this reason the gravelly land often brings higher prices than that gravel free.

[11] The soil is really a distinct soil type, the Merrimac gravelly sandy loam, but in this area it is mapped as a gravelly phase of the Merrimac sandy loam, in order to reduce as far as practicable the number of colors on the soil map.

MERRIMAC FINE SANDY LOAM.

The Merrimac fine sandy loam consists of brown fine sandy loam, rather heavy in places, about 8 to 12 inches deep, overlying light-brown or yellowish-brown fine sandy loam, which grades in the lower subsoil into coarse material, such as sandy loam, loamy sand, or a mixture of coarse sand and gravel. There is a reddish cast in the subsoil of some areas. In places, as at Berkeley Heights, this type caps hills of red shale, and here the lower subsoil in places contains fragments of red shale and is undoubtedly residual in origin.

About 1½ miles south of Morristown, on the other side of the trap mountain ridge, an area of Montalto fine sandy loam has been included with this type because of its small extent. This included area consists of a brown fine sandy loam, about 10 inches deep, overlying reddish-brown fine sandy loam, which passes at about 30 inches into a redder loamy fine sand. Some small angular fragments of basalt are on the surface and in the soil section.

The Merrimac fine sandy loam is found in the old lake regions and along the streams that deposited outwash from the glacial till. Important areas were mapped southeast of Morristown, in the northeast corner of the area, and in other places. Important developments of the type occur along the shores of old Lake Passaic, many of them on high benches or even on steep slopes along the sides of mountains, as, for example, the areas north of New Providence. In places the type occurs on the tops of small knobs and hills. The topography as a whole varies from rather steep to nearly level.

Most of the Merrimac fine sandy loam has been cleared of hardwood forest and is under cultivation. Both the general farm crops and market-garden crops are grown. In many places, as at Berkeley Heights, it has been cut up into small farms and is being developed by people from southern Europe. Here truck crops, such as tomatoes, cabbage, peppers, onions and potatoes, together with grapes and small fruits, are produced. There are some large commercial peach orchards on the type. The soil is handled much like the Merrimac sandy loam. Manure or fertilizer is necessary for good yields, where the soil has become impoverished from continued hard use.

It probably would pay to grow winter cover crops to be plowed under in the spring, and it unquestionably would be good economic practice to grow an occasional crop of soy beans or clover, to supply needed humus and nitrogen.

MERRIMAC LOAM.

The surface soil of the Merrimac loam is a brown mellow or gritty loam with a depth of about 8 to 12 inches. The upper subsoil is a light-brown to yellowish-brown gritty loam. This in places passes abruptly into yellowish-brown friable clay or clay loam containing

much grit. In nearly all places the extreme lower subsoil is more sandy and friable than the upper subsoil and it varies from yellowish-brown sandy loam to coarse sand, with a reddish cast here and there. Some gravel, consisting for the most part of gneiss, is present in many places. The area mapped south of Wharton is a silt loam, and represents an inclusion, not separated on account of the small extent of that type.

The Merrimac loam occurs in the same general region as the other Merrimac soils, and has a rather small total area. Some of the more important areas are on the terraces along the Rockaway River east of Silver Lake, southeast of Morristown, southwest of New Providence, and near Hanover Neck. Typically, it occurs on flat terraces. It is well drained.

Most of this type is cleared and farmed, being used chiefly for the production of the general farm crops. It is not as difficult to plow or cultivate as its gravelly phase, and has a slightly higher value as farm land. Generally the cultivation is efficient, good rotations are practiced, and some fertilizer is used. Rather liberal additions either of manure or fertilizers are essential for the production of good crops. The growing of legumes, such as soy beans and clover, may be expected to improve the soil, especially when a crop is plowed under occasionally.

Merrimac loam, gravelly phase.[12]—The Merrimac loam, gravelly phase (or Merrimac gravelly loam), is a brown gritty loam passing into a subsoil of similar color and texture and then into light-brown gritty loam, with yellowish-brown gritty clay, sandy clay, or clay loam below depths of about 2 feet. The lower subsoil in many places is an orange-colored sandy loam, coarse sandy loam, loamy sand, or coarse loamy sand. In places the subsoil is reddish. The surface soil varies in depth from about 6 to 10 inches. Scattered over the surface and through the soil section are large quantities of gravel and cobblestones of gneiss, with some of trap rock, quartzite, sandstone, and other rocks.

The Merrimac loam, gravelly phase, occurs in the same general regions as the other Merrimac soils, mainly along the streams which flow either through the glacial-till sections or out of these sections. In the latter case the phase has been mapped on the outwash plains south and west of the moraine. Large, important areas were mapped near Budd Lake, Ledgewood, and here and there along the Rockaway, Passaic, and Whippany Rivers. The largest body lies near Morris Plains. As a rule the topography is nearly flat, though some areas occupy small hills and knolls. The drainage is adequate.

[12] This soil is really a distinct soil type, the Merrimac gravelly loam, but in this area it is mapped as a gravelly phase of the Merrimac loam in order to reduce as far as practicable the number of colors on the soil map.

This is rather an important soil and is used, where not occupied as building sites, for general farm crops. Some vegetables are grown, but not as extensively as on the sandier types. Dairying in most places is an important industry. The cattle are pastured on the adjoining low, bottom or swampy soils.

The yields compare favorably with those of any of the other soils in the area. The crops are given about the same fertilizer treatment as on the Washington loam. The common four-year or five-year rotation is practiced. This soil is somewhat difficult to till, owing to the gravel and cobblestones present, but because of its flat surface it is more easily handled than some of the other gravelly soils. It is held at about the same price as the Merrimac sandy loam.

DUNELLEN SANDY LOAM.

The surface soil of the Dunellen sandy loam is a dark reddish brown sandy loam, 8 to 12 inches deep. The subsoil is a sandy loam, of a lighter shade of reddish brown, grading at 18 to 25 inches into Indian-red friable sandy clay, which normally is coarser and more friable below 30 to 36 inches, consisting in this lower part of sand, loamy sand, coarse sand, loamy coarse sand, coarse sandy loam, or sandy loam. The distinctive purplish-red color is due to material derived from Indian-red Triassic shale and sandstone. The material contains many dark-green and black particles.

As mapped, the type includes patches of sand, loamy sand, coarse sand, and fine sandy loam. In places the material giving rise to this soil is so thin that the underlying red shale is reached at about 3 feet. In the vicinity of Piscataway the type includes a patch of material the origin of which is similar to that of soils occurring in the Coastal Plain, but which differs from the Coastal Plain soils in containing so much Indian-red material of Triassic origin as to have a typical purplish-red color.

The material consists of glacial outwash, and occurs south and west of the till regions. Large areas were mapped near Metuchen, Plainfield, Dunellen, Bound Brook, and Manville. The material is partly of wind-blown origin in many places, as along the Millstone River at East Millstone and Weston, south of Bound Brook, along Ambrose Brook at Newtown, and in the large areas near New Market. A few small bodies within the morainic regions have a stratified reddish soil.

The surface of the larger areas is flat to gently undulating, but many of those near streams are sloping. The drainage is good.

The Dunellen sandy loam is a rich, productive soil. It is not important in the agriculture of the area, however, because most of it is situated in and near towns within commuting distance of New York City, and consequently is used more for building sites than for farming. Much of it, however, is under cultivation.

Irish potatoes, tomatoes, beans, peas, cabbage, beets, asparagus, and other truck crops are grown on land of this type. In places wheat, oats, rye, buckwheat, corn, and timothy and clover hay are important. The yields, methods of handling, and fertilization are very similar to those on the Merrimac sandy loam. However, many of the farmers on this type do not manage their farms as carefully as those in most of the better farming sections in the area.

Most of the land is being cut up into building lots and is held at high prices, and many of the small tracts now farmed are rented, pending their sale as building sites.

The table below gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the type:

Mechanical analyses of Dunellen sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170931	Soil	2.8	15.8	14.4	29.9	10.7	19.1	7.2
170932	Subsurface	4.7	17.1	15.2	32.1	7.5	14.9	8.5
170933	Subsoil	4.0	19.8	16.7	38.8	7.9	6.4	6.4

DUNELLEN LOAM.

The surface soil of the Dunellen loam is a brown loam with an average depth of 8 or 10 inches. The subsoil is a dark reddish brown loam which grades at depths ranging from about 15 to 22 inches into Indian-red or dark reddish brown friable clay, and this usually passes into sandy loam, coarse sandy loam, or other material more friable than the upper subsoil, at depths of about 30 inches. In places the subsoil has a more yellowish brown color, with only a slight reddish cast, the color becoming more reddish below. Considerable small rounded gravel, consisting mainly of red sandstone, though some of it is composed of gneiss and trap rocks, is found in places on the surface and through the 3-foot section. Where the gravel occurs in abundance it has been shown on the soil map by gravel symbols. In places, as in the area about 2 miles south of Plainfield, the soil at the immediate surface consists of dark reddish brown loam and below this at about 10 inches of reddish-brown loam, this grading into Indian-red sandy clay at about 30 inches. In a few places, in positions somewhat lower than common, the subsoil shows some yellow mottling. Here the soil represents a gradation between the Whippany and the Dunellen loam.

Included with this type, as mapped, are some areas derived from deposits of the Coastal Plain region. Important areas of this variation are mapped south of Stelton and in the vicinity of Clyde. This material is a dark reddish brown loam, 8 to 10 inches deep, overly-

ing friable Indian-red clay. Some rounded quartz gravel is present from the surface down. This gravel comes from the Pensauken formation.

The Dunellen loam occurs in broad belts in the general vicinity of Plainfield, Scotch Plains, Metuchen, Bound Brook, and Somerville. Other smaller areas are located south of Westfield, near Clyde, Stelton, and Mountainside, and in other places in the southeastern and east-central parts of the Bernardsville area. Its topography is flat to gently rolling, and its elevation ranges from 100 to 250 feet above sea level. As a whole it is a well-drained, productive soil.

The type has nearly all been cleared. Like the sandy loam soil of the same series, it is not an important soil in the agriculture of the area, owing to the fact that it is held for the most part as building sites, and much of it has been cut up into town lots. However, some of it is farmed, corn, oats, wheat, rye, buckwheat, Irish potatoes, and hay being the chief crops. Vegetable production is important in and near Plainfield and in some other places. The general farm crops are usually grown in rotation, the common succession being corn, oats, wheat (or rye), and grass for hay. The yields on the better farms are very good, comparing favorably with those obtained on the Penn silt loam.

The stable manure made on the farm is usually applied to sod land just before plowing for corn, and the oats and the wheat are fertilized with commercial fertilizer, usually a complete mixture. Wheat receives about 200 to 400 pounds of fertilizer per acre, and oats less.

The value of most of this soil is far in excess of its agricultural worth, owing to its favorable situation for suburban residences.

The Dunellen loam is a good, productive type of soil, and with good care it can be made one of the most productive soils in the whole area. It should be plowed deep and thoroughly, and the humus content should be increased by the addition of organic matter. Lime is especially needed where stands of clover and alfalfa are desired.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the type:

Mechanical analyses of Dunellen loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170937	Soil	4.3	14.0	7.2	11.0	11.1	39.9	12.4
170938	Subsoil	6.6	15.2	6.7	10.2	12.7	36.5	12.1

CHESTER LOAM.

The Chester loam consists of a brown to light-brown, friable, gritty loam, 8 to 12 inches deep, overlying a yellow, friable, gritty clay subsoil. In places the subsoil has a reddish cast, but this is not typical. The grit is derived from gneiss fragments, which are present in all stages of decay. Mica flakes and white feldspathic particles also occur here and there. Two narrow patches just west of the Chester station at the foot of a slope, included with this soil on the map, consist of a brown sandy loam with a yellowish-brown sandy clay subsoil. Near areas of the swampy Clyde soils, and in a few other low places, the lower subsoil is pale yellow in color and more compact than typical. The parent rock is generally several feet below the surface, but lies within the 3-foot section in a few places.

The Chester loam occurs in the west-central part of the area. Important tracts are mapped near Chester and Mendham, and between Calais and Ironia. The type has a gently rolling topography, much flatter than that of the stony and gravelly phases. Usually it occupies the flatter tops of hills rising to an elevation of about 800 feet above sea level. Except in local depressions, the type is well drained.

The Chester loam is a strong, productive soil and is nearly all cleared of the original timber growth. The same crops are grown as on the more extensive gravelly phase described below, and the yields, methods of handling, and the system of fertilization used are likewise very similar. The loam is a little easier to handle, owing to the smaller content of stone and gravel and to the smoother topography. As a consequence the value is usually slightly higher than on similarly located areas of the gravelly phase.

Chester loam, stony phase.[13]—The Chester loam, stony phase, is a brown to light-brown gritty loam, 2 or 3 inches deep, passing into yellowish-brown or yellow gritty loam, which grades below into gritty yellow clay loam or clay. It is largely in forest, a fact which explains the shallowness of the brown surface layer, which under cultivation is deepened by plowing. It differs from the Chester loam, gravelly phase (or Chester gravelly loam), in having an abundance of large rock fragments over the surface and through the soil and subsoil, and in being more steeply sloping. Some of it has been cleared, the larger stones removed, and the land put into cultivation. Much of the area mapped as the gravelly phase originally consisted of this stony phase.

[13] This soil is really a distinct soil type, the Chester stony loam, but in this area it is mapped as a stony phase of the Chester loam, in order to reduce as far as practicable the number of colors on the soil map.

The Chester loam, stony phase, occurs in the west-central part of the area. It is developed on the steeper slopes, and as a rule has a much steeper topography than the typical Chester loam and the gravelly phase of the Chester loam. It is well drained and in places subject to erosion, though the many large stones tend to prevent excessive washing.

The soil is not important in the agriculture of the area, owing to its unfavorable topography and stoniness. Chestnut was an important tree on this soil, but nearly all the trees have been killed by the blight. Oaks, hickory, maple, basswood, and ash are among the species flourishing at present.

The chief value of this soil is for forestry and pasture, at least under present economic conditions. Much of it could be cleared of the stones and made suitable for cultivation, but it is believed forestry is the best use to which most of the land can be put. The cleared areas will be adapted to the same crops as the gravelly phase of the Chester loam, but in general they will be more difficult to farm, as the slopes are for the most part steeper.

The value of this stony land in many places near the large "estate" farms is too high for consideration for farming. In other places it is held chiefly for value of the timber.

Chester loam, gravelly phase.[14]—The Chester loam, gravelly phase (or Chester gravelly loam), is a light-brown or brown gritty loam, about 8 to 10 inches deep, overlying brownish-yellow or yellow friable gritty clay. Angular fragments of gneiss are abundant over the surface and through the soil and subsoil, giving a decidedly gravelly character to the land. Usually it is impossible to bore more than about 15 inches into this soil with the soil auger on account of the gravel. The dry surface is grayish. In places the surface soil is shallow, and the yellowish subsoil comes near enough to the surface to give plowed fields a spotted brownish and yellowish appearance. The subsoil here and there has a reddish cast.

One mile north of Pottersville, on the slope north of Chester, and in a few other places, small areas of Chester gravelly sandy loam are included with this phase. A few very small patches of Chester loam and the stony phase of Chester loam are also included.

Half a mile southwest of Ralston, and in a few other places near the foot of the slopes, a narrow belt of hard sandstone has broken down to form a soil which is so nearly like the Chester loam, gravelly phase, and is so small in extent that it has been included with it.

The Chester loam, gravelly phase, is the most extensive of the Chester soils mapped in the Bernardsville area. It is associated in

[14] This soil is really a distinct type, the Chester gravelly loam, but in this area it is mapped as a gravelly phase of the Chester loam, in order to reduce as far as practicable the number of colors on the soil map.

occurrence with the typical Chester loam and the Chester loam, stony phase. All of these Chester soils occur in the west-central part of the area.

The topography varies from gently rolling to rolling. The phase occupies high hills, ridges, and hill slopes, at elevations ranging from less than 300 to over 1,000 feet above sea level.

The drainage is good. The gravel helps to keep the soil porous and to make it absorptive of moisture, and at the same time serves to retard erosion.

This soil is of great importance both because of its extent and of its agricultural value. It is nearly all under cultivation. The original forest growth was similar to that on the stony phase of the type.

The chief crops are corn, oats, wheat, and hay (timothy, redtop, and red clover). In addition, rye and buckwheat are grown extensively. Alfalfa is grown on many of the more nearly level areas near Chester and Mendham. Some fields with a very good stand of sweet clover were seen during the progress of the survey. A few years ago this soil was used extensively for peaches. At present this industry is less important, but there are still many large well-cared-for orchards. The little village of Oldwick is in the center of an important orchard district.

Dairying is practiced on nearly every farm. Practically all the milk is hauled to railroad receiving stations, where it is bottled, iced, and shipped to the larger markets for distribution. On a few farms situated several miles from a railroad some butter is made. The Holstein blood predominates in the majority of the dairy herds.

Hogs are raised in sufficient numbers to supply the home with pork, and only the surplus is sold. Chester White is the most common breed of hogs. Many of the "estate" farms make a business of raising purebred horses, cattle, hogs, and chickens. Poultry products form a large source of the income on most of the farms. Sheep are kept on some, but the fear of loss as a result of depredations by dogs tends to prevent an increase in the number of flocks.

Wheat yields range from about 15 to 25 bushels per acre, averaging about 18 bushels; corn averages about 40 bushels; oats, 25 to 30 bushels; timothy and red clover, from 1 to 1½ tons; and alfalfa, in several cuttings, about 5 tons per acre.

The main crops are grown in rotation. The most common scheme of crop succession is a five-year rotation, as follows; Corn, oats, and wheat (or rye), followed by timothy and red clover for two years. The timothy seed is sown in the fall, and the red clover is broadcasted over this with a wheelbarrow broadcaster in the spring. Alfalfa is sown either with wheat or rye late in August or with oats early in the spring. Very few inoculate for alfalfa, which probably accounts for reported failures to get a satisfactory stand on land that

has not grown the crop before. Alfalfa is usually allowed to occupy the land for four or five years before it is displaced by another crop.

Reapers and binders, mowers, manure spreaders, two-horse turning plows, three-horse or four-horse sulky plows, drills, and many different types of harrows are found on nearly every farm. An increasing number of farmers are building silos and purchasing small tractors, hay loaders, corn cutters, and reapers and binders.

Both stable manure and commercial fertilizers are used on land of this type. The prevailing practice is to put all the stable manure on the sod before plowing for corn. The small grains receive from 200 to 500 pounds per acre of fertilizer, applied with the drill at time of seeding. Wheat usually receives slightly more than the other grains. The prevailing brand used before the European war caused a shortage of potash was a 2–8–10 mixture. Fish-scrap fertilizers are frequently employed.

The price of this land in many places greatly exceeds its agricultural value, owing to the demand for it for summer or country homes by city people who give greater consideration to location and landscape features than they do to agricultural value. Consequently the land in this region is held at $250 to $1,000 an acre. In other places the soil can be bought for $50 to $100 an acre, depending upon nearness to market, good roads, topography, state of fertility, and improvements.

The Chester loam, gravelly phase, needs lime and deeper and more thorough tillage.

HAGERSTOWN SILT LOAM.

The surface soil of the Hagerstown silt loam is a brown mellow silt loam 8 to 12 inches deep. The subsoil is a brownish-red to yellowish-red moderately friable clay. In places the subsoil grades through yellow silt loam and reddish-yellow clay loam into reddish friable clay. On the slope just west of Pottersville the soil and subsoil are filled with small platy fragments of limestone, and this area is shown on the map by gravel symbols. Gravel symbols have also been used to show an area about one-half mile east of Peapack where the surface soil is thickly strewn with small fragments of chert and limestone. Several hundred acres of a brown gritty loam, underlain at about 10 inches by a friable yellowish-red clay, are included with this type as mapped near Pottersville on the east side of the Black River. This area contains rounded gneissic gravel and cobbles. Here the surface soil is probably of material derived from gneiss, but the subsoil appears to be largely limestone material. Gravel symbols also have been used to show the location of this area.

Areas of the type occur near Peapack, Gladstone, and Pottersville, and southwest of Ralston. It has a gently sloping topography and is everywhere well drained.

The Hagerstown silt loam is of small extent and, therefore, of little importance in the agriculture of the Bernardsville area, notwithstanding its productiveness. It is all cleared and under cultivation, and considered one of the strongest and best soils in the area for the general farm crops. A large proportion of it is seeded to alfalfa. Crop yields in general are somewhat higher than those obtained on the neighboring Chester soils. The soil is easily handled and well adapted to the use of all modern farm machinery. It is fertilized the same as the Chester soils. Dairying is relatively important on the Hagerstown areas.

This type has a higher value for farming than the associated soils, but since there are very few farms, if any, that are situated wholly on it, no accurate statement of its selling value can be made.

MONTALTO STONY LOAM.

The fine-earth surface soil of the Montalto stony loam is a brown silt loam about 6 to 8 inches deep. The subsoil typically is a brownish-yellow silty clay to clay, which grades below into reddish-yellow moderately friable to rather stiff clay, but in places is reddish yellow or dull red. It is not so stiff as the red clay subsoil of the Cecil soils of the Piedmont region of the south. Mixed with the finer material is an abundance of stone, consisting almost wholly of basalt. The only important exception to this is the body mapped in the southwest corner of the area, just south of Neshanic, where the stone consists of diabase.

The type occurs with the other members of the Montalto series on the Watchung and Sourland Mountains. It occupies, as a rule, the upper and steeper slopes and is well drained.

Nearly all of it is in forest, mainly hickory, maple, dogwood, basswood, chestnut oak, and in a few places cedar. About the only use made of the soil, aside from forestry, is for pastures. Much of it, however, owing to its steep topography, should always be kept in forest; a part of it could be converted into tillable land by removing the larger stones. Some land that has been improved in this way is mapped as the gravelly loam of the series.

MONTALTO GRAVELLY LOAM.

The Montalto gravelly loam consists of about 6 to 8 inches of brown silt loam, underlain by a rusty-brown, brownish-yellow, or reddish-yellow to yellowish-red moderately friable silty clay. The material is very gravelly from the surface down, the gravel consisting of fine-

grained basalt. In places gravel constitutes fully 50 per cent of the soil mass. The area mapped west of Oldwick and a few small patches mapped elsewhere are derived from a course-grained diabase, contain considerable gritty material, and are known locally as "mountain grit land." In some places there are still a few very large fragments of the parent rock in the fields. This soil has been derived from the underlying trap rock, except in those areas mapped at the foot of the steep slopes, where much of the material is of colluvial origin.

The largest areas of this type are those on the Watchung Mountains and on a hill just west of Oldwick. The topography is not as steep as that of the Montalto stony loam, nor is it as gently sloping as that of the Montalto silt loam. On top of the hills it is rolling to gently rolling. As a whole the drainage is good, but there are a few spots near areas of the Watchung silty clay loam where the drainage is imperfect.

The type is an important soil in the agriculture of the area, and at some time it has nearly all been cleared and farmed. In some sections many of the old farms have been allowed to revert to forest, but much of the land is at present farmed. The main crops are corn, oats, wheat, rye, buckwheat, and hay. There are many large peach orchards on the type, but the peach industry here is not as important as formerly. Before the development of the large peach districts in southern New Jersey this was one of the largest peach-growing sections in the country. Apples, pears, plums, and small fruits all do well, and are grown to a considerable extent. Alfalfa, though a minor crop, is increasing in importance (Pl. XV, fig. 2). Dairying is important. Poultry is raised on most farms, and there are a number that make poultry a specialty. South of Far Hills, near Basking Ridge and Green Village, south of Summit, and in other places many of the large estates make a business of raising purebred horses, cows, and hogs. In places trucking is important. Corn yields from 35 to 60 bushels per acre; oats, 30 to 50 bushels; wheat, 15 to 30 bushels; and hay (timothy and clover mixed), from 1 to 2 tons per acre. Crops are usually grown in rotations, and good tillage methods are in common use.

Improved farm machinery is used, except on the steeper slopes. The stable manure is usually applied to the land intended for corn. Small grains receive applications of 200 to 500 pounds of commercial fertilizer per acre.

Land of the Montalto gravelly loam varies considerably in value. Near the large country estates it often sells for several hundred dollars an acre; in other places the price is much lower.

Where it is properly handled this is an excellent soil, both for the general farm crops and for fruit. Much of it is in need of lime.

FIG. 1.—TYPICAL FARM BUILDINGS ON WASHINGTON LOAM, NORTHWEST OF SOMERVILLE.

FIG. 2.—ROLLING TOPOGRAPHY OF THE MONTALTO GRAVELLY LOAM.

Alfalfa in foreground, corn in middle distance.

FIG. 1.—FLAT TOPOGRAPHY OF THE PENN SILT LOAM.

Timothy and clover in foreground, and typical farm buildings, with hay and grain stacks, in background.

FIG. 2.—PEAR ORCHARD AND HAY FIELD ON PENN SILT LOAM.

MONTALTO SILT LOAM.

The Montalto silt loam is a light-brown or brown to light reddish brown silt loam, grading at depths ranging from 6 to 12 inches into reddish-yellow or reddish-brown silty clay loam, which passes into friable yellowish-red clay. In a few places, especially where the soil has been derived from diabase, as south of Neshanic and west of Oldwick, the soil contains more or less gritty particles of partly disintegrated rock. There are some small fragments of trap rock in many places, particularly near areas of the Montalto gravelly loam and stony loam types. At the foot of the hills where this soil has been mapped it is largely of colluvial origin, and grades into the Penn soils farther down the slope. In such places the underlying rock is red shale and the surface soil locally is a loam instead of a silt loam.

The type, which is associated with the other Montalto soils, occurs on gently sloping or gently rolling to nearly flat areas. The drainage is good, except near areas of the Watchung soils, where in places the underdfainage is poor.

The Montalto silt loam is rather an important soil in the area. It has been cleared and is used chiefly for growing the general farm crops. It is handled in about the same way as the Montalto gravelly loam. It is easier to cultivate and better suited to the use of improved farm machinery than the latter type.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the type:

Mechanical analyses of Montalto silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170939	Soil	1.1	3.9	1.8	7.4	24.7	49.4	11.8
170940	Subsoil	1.5	5.8	3.0	10.6	23.5	40.5	15.2

WATCHUNG SILTY CLAY LOAM.

The Watchung silty clay loam is a gray to brownish-gray silty clay loam, 6 to 10 inches deep, passing into mottled yellow and gray plastic silty clay loam or clay, which usually becomes tougher and more plastic with depth. In places the lower layer consists of an impervious plastic clay or clay pan, mottled with light gray or bluish-gray and yellow. In other places, as in the area 1½ miles south of Stirling, this lower stratum is a dull Indian-red, plastic, tough clay or clay pan showing some gray mottlings and containing fragments of trap rock. Locally the surface soil is a shallow, light-brown silt loam, and the subsoil is a yellow clay which passes into compact clay containing some brownish concretionary material. This variation is

better drained and as a rule lies between the better-drained Montalto soils and the more typical Watchung areas.

The type occurs in numerous places on the ridges of Watchung Mountain and on the top of Sourland Mountain, mainly in small patches on the seepy, poorly drained slopes and in depressions about the heads of drainage ways. The whole type is poorly drained to swampy.

The Watchung silty clay loam is of little agricultural importance, owing to its small area and poor drainage. Most of it has been cleared of the birch, maple, cedar, and oak with which it was originally covered, and is used for pasture. Many of the smaller areas are devoted to the general farm crops, and where the drainage is sufficiently improved fairly good yields are obtained. In general the soil is badly in need of lime.

PENN GRAVELLY LOAM.

The Penn gravelly loam consists of Indian-red silt loam to loam, underlain by brighter Indian-red, moderately stiff or brittle clay. In many places the material below depths of 10 to 20 inches is Indian-red silty clay. Angular fragments and small cobblestones of whitish, grayish, and reddish quartz and quartzite are abundant on the surface and through the soil mass. In many places the gravel content is so large that it is impossible to bore many inches into the soil. The bedrock, a conglomerate composed of quartzite, quartz, and some limestone pebbles in a red matrix, is encountered within the 3-foot section in places. About a mile north of Whitehouse there is an area in which gravel, similar to that occurring in the Washington loam, gravelly phase, is thickly strewn over the surface. Here the original fine soil material apparently has been washed away, exposing the Indian-red Triassic shale soil.

This type occurs in several large bodies in the central part of the area, along the northern border of the shale formation. Important areas lie near Peapack, Gladstone, Pottersville, and north of Oldwick. Smaller but important areas lie west of New Vernon, south of Morristown, north of Green Village, north of Whitehouse, and about 3 miles southeast of Chester. The type is ridgy or hilly, occupying hills which stand about 200 to 300 or more feet above the other Penn soils. Drainage is good. The gravel appears to make the soil rather porous, and at the same time tends to prevent excessive erosion on the slopes. Crops are likely to suffer during long dry spells, though the soil is not a droughty type, as is the Penn shale loam.

About 60 per cent of the type is cleared and farmed. Chestnut was the principal tree in the forest growth, but it has been killed to the ground by the blight. Oak and hickory are common trees. The cleared areas are used in growing corn, oats, wheat, rye, buckwheat,

and hay. Dairying is carried on in conjunction with the growing of general farm crops. The whole milk is sold and shipped to New York and other city markets. Some alfalfa and sweet clover are grown.

Corn ordinarily yields 35 to 40 bushels per acre; oats, 20 to 40 bushels; wheat, 12 to 20 bushels; and timothy and clover hay, about 1 ton. Peaches, apples, and pears all seem to thrive where they receive proper care. The type is rather difficult to plow and cultivate, owing to the presence of large quantities of stone.

A large proportion of the Penn gravelly loam lies close to those sections where well-kept country estates tend to increase the price of land. The price in these sections is often several hundred dollars an acre. In other places this soil can be purchased for $40 to $100 an acre, depending upon location, topography, and improvements.

This is a good soil especially well suited to the production of fruits. Sweet clover grows along all the highways, and can be established in fields with very little trouble. It gives large yields of forage, and improves the soil. When cattle have acquired a taste for this hay, they seem to do very well on it.

PENN SHALE LOAM.

The Penn shale loam is an Indian-red silt loam, underlain at about 8 to 14 inches by a bright Indian-red clay, both high in content of red shale fragments. The subsoil in nearly all places rests on the parent shale rock within the 3-foot section. In places the lower subsoil is very friable as the result of the presence of partly decomposed shale material. The shale fragments vary in size from very thin plates to pieces an inch or more in thickness.

The Penn shale loam is extensive in the southern half of the area, particularly in the southwestern part. The largest bodies are those near Neshanic, Centreville, South Branch, Liberty Corner, North Branch, Readington, South Plainfield, Bedminster, Lamington, and Stirling. The largest and most important areas occur on the steeper slopes of the Raritan (both branches), Dead, Passaic, and Lamington Rivers, Holland Brook, Pleasant Run, and other smaller streams In a few places it occupies the flat tops of hills. The drainage is usually excessive, especially on the slopes, and here, too, the soil is subject to much damage from erosion. Crops often suffer from lack of moisture in dry seasons.

The Penn shale loam is nearly all cleared, except in a few places where the slope is steeper than common and the parent rock is very close to the surface. White oak and hickory predominate in most of the forested parts; in a few places beech is abundant. The type is used mainly for growing the general farm crops, in conjunction with dairying. The cows as a rule are pastured on adjacent bottom soils

The yields, except during very wet years, are considerably lower on this type than on the Penn silt loam. The methods of handling soil and the fertilizer practice are about the same as on the associated upland soils.

The present value of this land for farming purposes in the strictly agricultural sections varies from about $40 to $100 an acre, depending upon location, depth to bedrock, and improvements. In some sections the land is held at much higher figures, but these areas are near small towns or large country estates, where the land has a value for purposes other than farming.

The type needs lime and organic matter. The slopes, especially, should not be allowed to go through the winter without a cover crop of some kind, such as rye or wheat. This would prevent much of the damage done by erosion as well as add fertility to the soil. Some of the steeper slopes now farmed should either be kept in permanent pasture grasses or devoted to forestry as farm woodlots.

PENN SILT LOAM.

The surface soil of the Penn silt loam consists of a dark reddish brown or dark Indian-red mellow silt loam 8 to 10 inches deep. The subsoil, which has the color of the parent rock, is an Indian-red clay of moderately friable to somewhat brittle nature. Varying quantities of Indian-red shale fragments are scattered over the surface and mixed with the fine earth throughout the soil section, increasing in size and number with depth. The shale beds are commonly encountered at depths varying from 20 to 36 inches below the surface.

In places along the southern border of the area near East Millstone, south of Somerville, west of New Brunswick, and in a few other places the surface inch or two seems to consist for the most part of material such as is found in the Coastal Plain region, and has a lighter red or brown color, suggesting that much of this section may have been covered at one time with this material. Small light-colored quartz gravel is present here also in varying quantities, and places in which it is abundant are shown on the map by gravel symbols. In the vicinity of Pluckemin, north and east of Readington, and in a few other places where this type is mapped near the Washington soils, the surface material to a depth of a few inches shows some influence from the old drift deposits. Here trap rock and gneiss gravel and cobblestones are abundant in places. Included with the type as mapped are some unimportant patches of Penn loam.

The Penn silt loam, which is one of the most extensive soils in the area, occurs in the southern half of the survey. The largest bodies are near Hillsborough, East Millstone, Somerville, north and west of New Brunswick, south of Oldwick, near Bedminster, North Branch, Pluckemin, Readington, and Whitehouse. It occurs as a rule in the

flatter, more nearly level country in the unglaciated part of the Triassic region. In a few places the surface is gently sloping. The type is well drained. In areas in which the depth to bedrock is shallower than ordinary, crops are likely to suffer from drought.

The Penn silt loam is nearly all cleared, the existing forested areas for the most part consisting of 5 to 10 acre tracts used for farm woodlots. The forest growth consists of red oak, white oak, chestnut oak, and other varieties of oak, hickory, maple, ash, some walnut, and sassafras. The most important crops are corn, oats, wheat, timothy and clover hay, rye, and buckwheat. (See Pl. XVI, Fig. 1.) Large quantities of peaches are grown, though the industry is less important than formerly, the Penn soils not being considered as good for fruit production as the Montalto and Chester soils. Alfalfa, steadily becoming a more popular crop, seems to do well. Vegetables, small fruits, apples, pears, plums, and quinces are grown by most of the farmers to supply the home; and there is usually a surplus for sale. Some commercial orchards are located on the type (Pl. XVI, Fig. 2). Dairying is the most important industry. Nearly every farmer has from 6 to 20 cows or more, usually grade Holsteins, and there are a few purebred herds. The milk is hauled to the nearest milk station, where it is iced and shipped to near-by cities. At Readington there is a factory where the whole milk is first put through a separator; the cream is sold to the city markets and the skim milk is made into a dry curd and shipped to factories for the manufacture of such articles as buttons. A few farmers make butter for town customers, but this is not a common practice. Poultry raising is an important business. It is usually carried on more as a side line, but a few farmers make this their main business. Hogs are raised on nearly every farm, but not many produce more pork than is sufficient to supply home needs.

A considerable part of this type has been under cultivation for 100 to 150 years, and as far as ascertained the yields are as large as they ever were. The yield of wheat ranges from 15 to 25 bushels per acre, with an average of about 18 bushels. Oats average between 30 and 35 bushels, and hay 1 to 1½ tons per acre.

The crops are grown by nearly all farmers in rotations. Corn is followed by oats and oats by wheat or rye. Timothy is seeded with the wheat or rye and clover is seeded in the spring upon the young timothy, with a wheelbarrow seeder. The common practice has been to allow the grass to stand for at least two years, but many of the farmers now cut hay only one year, making a four-year rotation. This change is due to the decreased demand for hay in the cities. The soil is well tilled, with heavy teams and improved machinery. Many are using small tractors for plowing. Silos are becoming more

popular each year. Large barns are used to store the crops. Many of the farmhouses are of substantial stone construction.

Dent varieties of corn are grown for both ensilage and grain. Manure is usually applied on the sod before plowing for corn. A few apply commercial fertilizer in the row at time of planting the corn. A majority of the farmers apply some fertilizer to oats, usually not more than 200 pounds to the acre. Wheat receives from 250 to 400 pounds of commercial fertilizer per acre. The common commercial fertilizer used is a 2–8–10 mixture. The farmers who apply some form of lime are getting the best results. Lime is commonly broadcasted and harrowed in after preparing the seed bed for wheat.

The land of the Penn silt loam has a range in value from about $75 to $150 an acre, depending upon location and state of fertility, as well as upon the number and condition of buildings and other improvements.

The type is well adapted to the general farm crops and to dairying. Yields of red clover would be greater if more lime were applied. Lime it is believed should have a regular place in the rotation. Much of the type would be benefited by deeper plowing.

LANSDALE GRAVELLY LOAM.

The Lansdale gravelly loam consists of a light-brown, brown, or chocolate-brown silt loam, about 8 inches deep, passing into chocolate-brown or yellowish-brown silty clay loam or silty clay. Both soil and subsoil contain large quantities of brownish or bluish argillite gravel. In some of the wooded areas there are many large fragments of argillite rock. These areas are indicated on the map by stone symbols. Some small areas of poorly drained Croton silt loam have been included with the type as mapped, owing to their small size.

The Lansdale gravelly loam occurs on the rather steep slopes of Sourland Mountain, south of Neshanic. The type is well drained.

The area of this type is comparatively small and only part of it has been cleared of forest, consisting of chestnut oak, red oak, hickory, dogwood, basswood, maple, and chestnut, with beech and elm numerous in certain localities. The cleared land is farmed, corn, oats, wheat, rye, buckwheat, and hay being the leading crops. Dairying is an important industry on nearly all of the farms, the cows being pastured on the steeper stonier areas and on the bottom soils. Peaches and apples are grown in a small way. The crop yields are somewhat smaller than those on the Lansdale silt loam, but larger than those on the Lansdale shale loam. Owing to the rather steep surface and the number of stone fragments, it is not an easy soil to till, and therefore it is not as well adapted to the use of modern farm machinery as many of the other soils. The soil seems to be much in need of lime.

The value ranges from about $25 to $70, depending mainly upon improvements.

LANSDALE SHALE LOAM.

The Lansdale shale loam consists of a light-brown to chocolate-brown silt loam, overlying yellowish-brown to yellow moderately friable clay or silty clay loam. Fragments of chocolate-brown, gray, and brown shale are abundant, the quantity increasing with depth in places. The parent bedded shale is usually encountered at depths ranging from about 20 to 36 inches.

Northwest of Gladstone is a ridge occupied by Berks shale loam, which, because of its small extent, has been included with this soil. The Berks shale loam is a light-brown silt loam, about 8 inches deep, overlying brownish-yellow silty clay. The bedrock in most places lies within 20 inches of the surface. The soil is filled with thin platy fragments of brown and dark slate-colored shale. It is much like the Lansdale shale loam.

The most important bodies of the Lansdale shale loam occur in the vicinity of Neshanic, Centreville, Basking Ridge, Liberty Corner, and Gladstone. The total area is small. Drainage is excessive in most places, and crops planted on it often suffer from drought.

The type is nearly all cleared and is used for the general farm crops common to the section. Apples and peaches do well with proper cultural methods. Potatoes and alfalfa are grown by a few farmers. Dairying is important. The yields, except in very wet seasons, are somewhat lower than on the silt loam and loam soils of the area. It has a wide range in value, owing to the fact that some of it is situated in the parts of the area desirable for suburban residence. For strictly farming purposes its value is not as high as that of many of the other soils.

In other localities this soil, the included Berks shale loam particularly, is used with marked success for the growing of Irish potatoes. The steeper slopes should be kept in grass or allowed to revert to forest, as they are subject to erosion. Cover crops should be used more extensively on nearly all of the farms, and the legumes, such as soy beans, sweet clover, and clover, should be grown more generally as soil improvers.

LANSDALE SILT LOAM.

The surface soil of the Lansdale silt loam consists of a light-brown, brown, or chocolate-brown mellow silt loam 8 to 10 inches deep. The subsoil begins as a yellowish-brown friable silty clay loam, but passes downward into a yellow or yellowish-brown friable silty clay. In a few areas the lower subsoil has a reddish cast, but this is not typical. Some brown or gray shale fragments are found here and there. In the area mapped on Sourland Mountain the soil is derived from dark-

bluish argillite, and bedrock is reached, in places at least, within the 3-foot section. The subsoil has essentially the same color as the parent rock.

Many patches of this soil were mapped near Centreville, Readington, Neshanic, Neshanic Station, and Basking Ridge. The topography ranges from nearly flat to gently sloping or rolling. The drainage is well established.

This is not an extensive soil type. Almost all of it has been cleared and is devoted to the same crops as the Penn silt loam, with which it is closely associated. It is handled in the same manner and gives about the same returns as the latter type. The value of the two soils is the same where they are similarly situated.

CROTON SILT LOAM.

The surface soil of the Croton silt loam is a gray silt loam with an average depth of 8 to 10 inches. The subsoil is a yellow or pale-yellow plastic clay mottled with gray, passing into a stiffer clay, which below about 24 inches consists of a tough, compact clay or clay pan mottled yellowish brown and bluish gray. In some places the clay-pan layer is not reached above 30 inches, and varies from dull brown to mottled yellow and gray in color. Some of the smaller areas included with this type are brown or red in the surface soil, with mottled material below. The type as mapped also includes some silty clay loam. On Sourland Mountain some large argillite fragments are present. These are indicated on the map by stone symbols.

The Croton silt loam occurs in a great many rather small patches scattered over the southwestern quarter of the area. It is found in small depressions or flats, often at the heads of small drainage ways. Some areas are mapped on the slopes of Sourland Mountain, where seepage occurs. This is a poorly drained soil, though where the surface soil is red or brown in color it is not so poorly drained as where the color is gray.

This is not an extensive soil. Most of it has been cleared. The principal native trees are turkey or black oak, post oak, ash, birch, maple, and ironwood. Much of it is used for pasturing dairy cows, but a considerable part is devoted to the general farm crops. Where the soil has been well drained and limed and the season is favorable it gives fair returns. Corn and wheat do not seem to be well suited to it; rye and hay give better results. Alsike clover thrives in places where red clover does not succeed. The type is handled and fertilized in the same manner as the soils with which it is associated, for it occurs in such small patches that the farmers have not usually given it any special treatment, except to improve the drainage.

This land is low in organic matter and requires draining and liming. The heavy clay-pan layer makes it a difficult soil to drain satisfac-

torily. It affords good pasturage during most of the season, and should, where possible, be used for this purpose.

SASSAFRAS SAND.

The Sassafras sand, as mapped in this area, consists of a brown sand, with a thin layer of light-gray sand at the immediate surface in the wooded sections, underlain at depths of about 5 to 7 inches by an orange-colored to reddish-yellow sand of a somewhat loamy structure. There are some included unimportant patches of Sassafras sandy loam, Lakewood sand, and Norfolk sandy loam, deep phase. Fragments of a red ironstone and gravel are present in places.

The Sassafras sand occurs in the southeastern corner of the area, east of New Brunswick and near Sayreville. It is a well-drained soil.

The type is of very little importance in the agriculture of the area. It is nearly all undeveloped. Near the industrial town of Sayreville most of the cleared land has been dug over for the underlying clay. The native growth consists of several kinds of oak, sassafras, and other trees. The land is used to a small extent for garden vegetables and general farm crops. It is handled in about the same way as the Sassafras sandy loam.

SASSAFRAS SANDY LOAM.

The Sassafras sandy loam consists of a brown sandy loam, 8 to 10 inches deep, overlying yellowish-red sandy loam, which grades into sandy clay or coarse sandy clay of reddish-yellow color. Some small quartz gravel is scattered over the surface in most places, and reddish Triassic gravel appears in many of the areas on the north side of the Raritan River. The area near Bonhamtown contains enough coarse sand to give a texture approximating coarse sandy loam. The areas east of Bonhamtown and those southwest of that place on the north side of the river are situated in the vicinity of large clay pits, which are indicated on the map by the mine symbol. The area mapped east of Sayreville is considerably mixed with other soils, which could not be satisfactorily separated, owing to the small size of the areas. In places in this section the surface soil is a brown loamy sand, which grades into reddish-yellow sandy loam with mottled gray and yellow clay coming in below. On the shoulders of some of the small hills this clay is at or near the surface.

The type is associated with the other members of the Sassafras series on both sides of the Raritan River. It occurs in gently rolling to gently sloping areas and has good drainage.

It is nearly all cleared, and is used for growing corn, wheat, hay, and oats. There are many large gardens on it, where truck crops are grown for sale. Most of this land is owned or used by men who labor in the clay pits or in the small near-by towns and farm only in

a small way. This is one of the best soils in the State for general farming and the growing of truck crops for the mid-season or late summer markets. In other less thickly settled sections it is highly prized for the growing of tomatoes, sweet potatoes, Irish potatoes, corn, string beans, muskmelons, sweet corn, peppers, and the general farm crops. In this area the real estate value far exceeds the farming value.

SASSAFRAS LOAM.

The Sassafras loam consists of a brown loam underlain at 8 to 10 inches by yellowish-brown clay loam, which passes into an orange or reddish-yellow friable sandy clay. Usually the lower subsoil is more sandy than the upper subsoil. In many places the upper subsoil is a reddish-yellow friable sandy clay. In places the surface soil is rather gritty. Included with the type, as mapped near Bonhamtown, are some small areas of sandy loam, sand, and, in depressions, Portsmouth loam and Muck. In the wooded areas the brown surface layer is not nearly as deep as in cultivated fields.

The largest and most important areas of this soil occur at Bonhamtown, Piscataway, south of Metuchen, and near New Brunswick. Its surface is nearly flat to gently rolling. The land is well drained, except in the included depressions, commonly containing other soils, which were mapped with this type because of their small extent.

The Sassafras loam is not of great importance in the agriculture of the area, though it is the most extensive of the Sassafras soils. Much of it is located in and near the city of New Brunswick, in the developed section near Piscataway, and around Bonhamtown. Some of it is still covered with oak forest. In some sections it is used for farming, corn, oats, wheat, rye, and hay being the leading crops. Some alfalfa is grown and does well. A number of farms are devoted to growing truck crops for near-by city markets. The New Jersey Experiment Station is located in part on this soil. Crops properly managed give very good returns, for it is a soil that responds readily to good cultural methods including crop rotation and the use of manure and commercial fertilizer. Its value is enhanced by favorable situation for residence sites.

ELKTON CLAY LOAM.

The surface soil of the Elkton clay loam is a light-gray to whitish clay loam, 6 to 8 inches deep. The subsoil is a whitish or light bluish gray silty clay, with gravel and sand in the lower part of the 3-foot section. In places the subsoil is a plastic, heavy clay, mottled gray and yellow in the upper part and bluish gray and reddish yellow in the lower part, with sand and gravel in some places, and in other places continuing as heavy clay to 40 inches or more. On some of the small hummocks that are rather common in areas of this type

the soil is a light-gray or bluish-gray silty clay loam, grading into light bluish gray silty clay loam or silty clay, compact in places, and dry in the lower subsoil, owing to the impervious character of the overlying material. Gravel and sand are found at depths of about 3 feet in these hummocks. In places the surface soil is a light-gray sandy loam, and again some areas have a dark-gray or brown layer at the surface. Included with the type are some small areas of poorly drained alluvial soil occurring along the borders of very small streams.

The Elkton clay loam occurs mainly between Piscataway and Metuchen. One area lies near the New Jersey Experiment Station in New Brunswick.

This is a low, imperfectly drained soil occurring in depressions and flats. The greater part of it is covered with a growth of pin oak, sweet gum, swamp maple, hickory, elm, sycamore, birch, and ferns.

BIRDSBORO SILT LOAM.

The Birdsboro silt loam is a chocolate-brown or reddish-brown silt loam, 8 to 12 inches deep, overlying lighter Indian-red silty clay loam containing more or less grit. The extreme lower subsoil in places has a deeper Indian-red color, and varies from a friable gritty clay to a sandy loam. Gravel of quartz, red sandstone, trap rock, and quartzite is abundant locally in the lower part. In places quantities of gravel are present on the surface and scattered through the 3-foot section. These gravelly areas are shown on the soil map by gravel symbol. Included with the type, as mapped near Woodfern, is an area in which both surface and subsoil consist of chocolate-brown sandy loam.

The Birdsboro silt loam is developed on flat to slightly undulating terraces in Somerset and Middlesex Counties. The largest and most important bodies occur along the branches of the Raritan River. It is a well-drained soil.

The type is not extensive, but nearly all of it is cleared and in cultivation. The general farm crops of the region, corn, oats, wheat, and timothy and clover hay are grown, together with some rye and buckwheat. Alfalfa does well and is important in many places. Dairying is practiced on nearly every farm, the cows being pastured on the rather wide first-bottom soils that lie adjacent to this type. The milk is usually sold to a local receiving station, where it is shipped whole to the large city markets. The farmers nearly all raise enough pork, vegetables, fruit, and poultry to supply their own wants, and many have a surplus of these products to sell. Crop yields are equal to if not a little better than those obtained on the near-by Penn silt loam.

The crops are grown in rotations, and good tillage methods are used. Improved farm machinery is common, and in recent years

many owners of this soil have purchased small farm tractors. The type is considered a good, strong soil, even better than the Penn silt loam, and often brings from $10 to $20 more an acre.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the type:

Mechanical analyses of Birdsboro silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170960	Soil	1.9	7.2	3.4	8.9	12.4	50.2	15.8
170961	Subsoil	.7	6.0	3.4	8.9	12.0	47.4	21.5

ROANOKE SILTY CLAY LOAM.

The Roanoke silty clay loam, to a depth of about 4 to 6 inches, is a gray to whitish silty clay loam to heavy silt loam, underlain by mottled gray and yellow or bluish-gray and yellow silty clay loam, which passes into bluish-gray or a mottled gray and yellow silty clay, with a tough clay layer at depths ranging from 15 to 24 inches. The material in this layer has a mottled bluish, red, yellow, and gray color, and the structure of a clay pan. In forested areas the gray surface layer is only 1 or 2 inches thick.

This type is associated with the Birdsboro silt loam, occurring on the second bottoms of the North Branch of the Raritan River and its tributaries. The largest and most important areas are east of Burnt Mill, near Lamington, southwest of Bedminster, and in other places in this same general region. It occurs on flat or depressed areas and is poorly drained.

The Roanoke silty clay loam, while of rather small extent, is important locally. About half of it is cleared. The existing forest growth consists of maple, birch, white oak, pin oak, hickory, and elm. Many of the larger areas are used for pasturing dairy cattle, for which use it seems to be well suited. Many of the small bodies that are adjacent to the Birdsboro silt loam are farmed with that soil, and in favorable seasons give fair returns. These areas have nearly all been drained. Open ditches are used in the wettest places and tile drains elsewhere. As a rule the yields are poor. Weeds tend to crowd out the grasses, and corn shows the effects of unfavorable moisture conditions. Where the land is drained properly and heavily limed, the yields are much better. Rye seems to do better than wheat, and alsike clover yields better than red clover.

PAPAKATING SILT LOAM.

The Papakating silt loam consists of a mucky black, dark-gray, or very dark brown silt loam, overlying mottled gray and yellow,

black, or bluish silty clay loam to silty clay extending to 3 feet or more. In places the lower part of the subsoil consists of bluish-gray loamy sand or sandy loam. Included with the type as mapped near Green Village and northwest of Hanover Neck there are small areas having a surface soil of brown silt loam, 6 to 8 inches deep, and black muck or black silty clay in the lower part of the 3-foot section.

The type occurs in the swampy, poorly drained first bottoms of many of the streams in the glaciated sections of the area or along the streams which flow from these sections. The largest and most important developments are on the upper part of Black River, here and there along the Passaic River, along Great Brook, and in a number of other places in the western and northern parts of the area. In its native state it supports two types of vegetation: (1) Rushes and other water-loving grasses and sedges, in the wetter areas, and (2) a growth of swamp maple, sweet gum, pin oak, elm, hickory, and bushes in areas less wet. Some large tracts have been cleared and at least partly drained. These are used with other bottom soils for pasture.

PAPAKATING SILTY CLAY LOAM.

The Papakating silty clay loam consists of a dark-gray, brown, or brownish-black silty clay loam, passing into a mottled gray and yellow, blue, or black, plastic, heavy clay. In places the lower subsoil is a very tough dark-brown clay, mottled with gray.

This type is of the same origin and is found in the same relative positions as the Papakating silt loam. The two soils are alike in being very poorly drained, and the tree growth is the same on both. Where used at all the type is used for pasture.

PODUNK LOAM.

The Podunk loam consists of a brown, dark-brown, or grayish-brown loam, ranging in places to silt loam, underlain at 8 to 12 inches by a yellow or brown sandy or gritty clay, which becomes more sandy below and has here and there a slight reddish cast. In places the subsoil is mottled with gray and yellow, but this mottling is not typical and rarely occurs in the upper subsoil. Gravel, cobblestones, and bowlders of gneiss are abundant in many places.

This type is developed along the streams of the northern and eastern parts of the area. It is a first-bottom soil, composed of materials which have been washed from the Gloucester soils. The largest areas lie along the Passaic and Rockaway Rivers, where they are associated with the Papakating soils. The Podunk loam is much better drained than the Papakating soils. It is used for the most part as pasture and makes excellent grazing land during even the

hottest summer months. A little of it is used for the production of corn, hay, and truck crops, but as the land is overflowed these crops are subject to more or less damage.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the type:

Mechanical analyses of Podunk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170919	Soil	2.9	9.8	4.3	12.5	13.4	37.9	19.2
170920	Subsoil	6.0	12.1	4.6	11.1	11.7	36.9	17.5

CODORUS LOAM.

The typical Codorus loam consists of a brown to light-brown, mellow, gritty loam, overlying a light-brown to yellowish-brown loam, which becomes more sandy in the lower part of the 3-foot section. As mapped in this area the type lacks uniformity. In many places the subsoil varies from clay to sand. Included with the type are some patches of Codorus sand and Codorus sandy loam. Mica flakes are usually present in the soil and subsoil, but they are not so abundant as in some areas of Codorus soils mapped in parts of Pennsylvania. Gneiss gravel, cobblestones, and bowlders are present in some places. In sections where this soil is composed of wash derived from the Montalto soils the surface soil in places is a reddish-brown loam to silt loam and the subsoil is a brown sandy loam to silty clay.

The Codorus loam occurs along the streams flowing through or from the Chester and Montalto soils and represents material washed down from these soils by running water and deposited on the flood plains of the streams. It is subject to overflow, but is fairly well drained, except, of course, during periods of inundation. It is not an extensive soil. Most of it occurs in narrow belts along small streams which have cut rather deep valleys. It is used in the same way as the Bermudian and Podunk soils, mainly for pasturing dairy cows.

WEHADKEE SILTY CLAY LOAM.

The Wehadkee silty clay loam consists of gray silty clay loam, passing abruptly into bluish-gray or a mottled bluish-gray and yellow plastic clay or silty clay. In some places the lower subsoil is a dull reddish, tough, plastic clay with some gray and yellow mottling.

This is a first-bottom soil subject to frequent overflows. It occurs along the Passaic and Dead Rivers south of Stirling and in a few other places. It differs from the Codorus in being poorly drained at all times. It is derived for the most part from wash from the Mont-

alto soils. In extent and use it is of minor importance in the area. Much of it is still covered with pin oak, maple, birch, hickory, elm, weeds, and grasses. Where cleared it is used as pasture land.

BERMUDIAN SILT LOAM.

The Bermudian silt loam is a dark reddish-brown or chocolate-brown silt loam, grading into dark Indian-red, friable, heavy silt loam to silty clay loam at depths of about 10 to 12 inches. This usually extends to 3 feet or more without much change. In many places a lighter more friable layer is found in the lower part of the 3-foot section. There are a few wet, mucky, or swampy places in many of the larger areas, and here the subsoil is usually heavier and is mottled with gray and yellow. These wet spots occur on patches too small to map. Small rounded gravel, mostly of red sandstone, is found here and there. As mapped along the small streams flowing through and out of the Wethersfield and Dunellen soils in the southeastern part of the area, as near Metuchen and Westfield, the type is variable, though for the most part it has a reddish surface soil and subsoil. There are, however, included areas in this region where the surface soil is brown and the subsoil a brown or yellowish-brown silt loam. The typical material is derived almost entirely from wash from the upland soils of the Penn series.

The Bermudian silt loam occurs in the southern part of the area along streams flowing through areas of red Triassic shale and sandstone. It is a fairly well-drained soil, except during periods of overflow.

The type has been cleared of most of its native timber. Along the banks of the larger streams, willow, elm, and walnut are found. This soil is used mainly as pasture land, for which purpose it is highly prized. It supports an excellent stand of pasture grasses which remain green even during long droughts. On nearly all farms the number of cows kept is in direct proportion to the acreage of bottom-land pastures. In places horses, sheep, and hogs are grazed in these pastures along with the dairy cows. In a few places in the wider bottoms along the Raritan River the land is cultivated, the general farm crops being grown. There is some risk of losing the crops, though the wide bottoms are not often overflowed during the growing season. In the summer of 1919 large acreages of wheat, corn, oats, rye, and other crops were ruined by floods, and in places grain that had been cut and was standing in the fields in shocks was washed downstream.

MUCK.

Muck consists of black, well-decomposed vegetable matter, with some intermingled inorganic or mineral soil material, such as sand, fine sand, and silt. The organic deposit is 24 inches or more deep

(an 8-foot auger was used in one place in the Black Meadows, but the bottom of the deposit was not reached). This is underlain by a pale yellowish gray loam or gray silty clay, sandy clay, or clay. In places there is no clay layer, and the lower subsoil is a gray or greenish-gray sand. A mass of brown peaty material is encountered in places at a depth of about 15 inches and continues downward to the sand or clay stratum. In the uncleared areas the surface inch or two of the material contains the undecayed roots of grasses and shrubs.

Three classes of Muck have been shown on the map: (1) Typical Muck, (2) an intermediate phase, and (3) a shallow phase. It was not possible everywhere to separate the small areas of these, and therefore in places small patches of the phases are included with the typical Muck. In the large swamps also there are a few small ridges of Whippany and Merrimac soils, which, owing to their small extent, could not be separated on the map.

Important areas of typical Muck occur in the Black Meadows, Great Swamp, Troy Meadows, and in the smaller swamps near Ledgewood Station, near Budd Lake, and in a great many other places scattered here and there throughout the glacial section of the area. It is a poorly drained soil, and unless drained nothing can be done with it. Most of it is covered with a tree growth including pin oak, swamp maple, birch, willow, and sycamore. Mosses and grasses growing in tussocks are common, and there are many places covered with marsh grasses and other plants where there are no trees.

These areas of Muck, situated, as most of the large ones are, within 30 miles of New York City, could be developed and converted into very valuable land. A considerable acreage of Muck has been at least partly drained, but there are really no very large areas that have been properly drained. The partly drained areas are used for pasturing dairy cows during summer months, especially in the dry seasons. At other times the soil is very miry and will not support the weight of an animal. In the Black and Troy Meadows and in a few other places small tracts have been more thoroughly reclaimed and here corn and large quantities of onions, potatoes, cabbage, and beans are produced.

West of this area at Great Meadows there is a large well-developed tract of Muck, upon which the growers are averaging from 600 to 700 bushels of onions a year per acre, and in addition to the onions they sometimes get one to two crops of lettuce from the same ground. Celery is another crop that does very well on the Muck and usually returns good profits to the grower.[15]

The best-developed sections of the Great Meadows tract often sell for $400 or even $600 an acre. The important factor is drainage.

[15] See the Muck description and agricultural practices given in the report of the Soil Survey of the Belvidere area, New Jersey.

To reclaim completely the large areas, known as the Great Swamp, Black Meadows, and the Troy Meadows, would involve the expenditure of large sums and require the services of an expert drainage engineer. It is believed these areas could be drained economically with a view of using them in production of onions, celery, and similar crops.

Muck, intermediate phase.—The intermediate phase of Muck consists of black organic soil exactly like the typical Muck, except that it occurs in shallower deposits, the layer of decomposing vegetable matter ranging in depth from 10 to 24 inches. It is associated in most places with the typical Muck, but here and there in the northern and western parts of the area small patches of this phase occur alone. Like the typical Muck, this phase has not been reclaimed to any great extent.

Where drained it is used for the same purposes as the areas of deeper deposits. In other places outside of this area, where it has been reclaimed on an extensive scale, the yields are stated to be about the same as the typical Muck. The latter, however, is held at somewhat higher prices.

Muck, shallow phase.—The shallow phase of Muck differs from the typical and the intermediate phase in that the organic deposit is not more than 10 inches deep, most of it ranging from 7 to 10 inches. The underlying material in most cases is a gray or greenish-gray sand or a brown to gray silty clay, sandy clay, or clay. In some places where clay is found in the upper part of the subsoil, the lower part of the subsoil is a gray or greenish-gray sand or loamy sand. There are included with this phase small patches of typical Muck, and of the intermediate phase, some Clyde loam, and, in a few places, some Merrimac and Whippany soils; but these occur only in patches too small for satisfactory mapping. Only a small total area of the shallow phase is mapped in the Bernardsville area. When reclaimed, the shallow soil yields about as well as the deeper Muck.

TIDAL MARSH.

Tidal Marsh is the term applied to low tidal flats covered with grass. The soil material usually consists of brown silty clay loam or silty clay grading into black or dark bluish silty clay. In places the material is black from the surface down, and is often very mucky; that is, high in content of decaying vegetable matter. Considerable quantities of organic matter consisting of the roots and leaves of grasses in all stages of decay are found near the surface in nearly all places.

The Tidal Marsh mapped in this area occurs about the mouth of the Raritan River. "Salt hay" is cut from this marsh, and is used by factories for packing breakable goods, and to some extent as coarse feed and bedding for horses and cattle. Similar marshland in south-

ern New Jersey near Millville and elsewhere has been diked, drained, and used very successfully for the growing of strawberries, tomatoes, and other truck crops, as well as for hay and corn.

ROUGH STONY LAND.

Rough stony land includes rough areas, mostly steeply sloping, so covered with fragmental rock and so cut by rock outcrops that they have little or no agricultural value. Gneiss, sandstone, and shale occur through the soil. The greater part of this classification represents rough stony areas of Chester and Gloucester soil, but small areas of Montalto and Penn types occur. The soil material between the stones does not differ in character from typical soils of these series.

Rough stony land occurs most extensively in the mountain sections of the area, where it is confined largely to very steep topography. It is forested land, supporting the same types of forest as the soil types associated with it in the different localities where it occurs. It is valued almost wholly for its timber, and its best use is for forestry.

CLAY PITS.

Certain areas have been rather thoroughly worked over in the process of getting out the underlying deposits of clay for industrial uses. These areas comprise pits and soil-refuse dumps, and have no value for agriculture. They occur within or adjacent to areas of the Sassafras soils and are shown on the map by the word "clay" and the mine symbol.

SUMMARY.

The Bernardsville area is situated in the central part of northern New Jersey. In outline it is rectangular. It contains parts of 7 counties and covers 725 square miles, or 464,000 acres. It lies within three main physiographic divisions, viz, the Coastal Plain, Highlands, and Piedmont Plain. These divisions differ in topography, ranging in surface characters from low-lying plains to high ridges, mountains, and valleys, and in elevation from sea level, as along the Raritan River east of New Brunswick, to over 1,200 feet above sea level in the northwestern part of the area. The region is drained into the Atlantic Ocean through the Raritan and Passaic Rivers, the Raritan receiving the run-off from all but the northeastern part. As a whole the drainage is good, but in many places in the Passaic basin natural drainage is poorly developed.

The population is composed largely of descendants of the original settlers, who came from northern Europe. In recent years the people from Russia and southern Europe have settled here, especially on the truck soils near the towns.

The area is well situated with reference to markets and is well supplied with modern means of transportation, including roads, railroads, trolleys, and canals.

The climate is marked by a rather wide range in temperature, though extreme temperatures are of short duration. The rainfall is sufficient and well distributed throughout the growing season. The length of the growing season varies from 157 days in the northern sections to 181 days in the southern end of the area.

The agriculture consists of the growing of general farm crops, such as wheat, corn, rye, timothy, clover, and buckwheat, in conjunction with dairying. Poultry, fruit, and truck are important in many places.

The soils of the area lie in seven soil provinces, viz, Piedmont, Appalachian Mountain, Coastal Plain, Glacial, Glacial Lake and River Terrace, Limestone Valleys, and River Flood Plains. Forty-eight separations were mapped.

The Washington soils are perhaps the most popular of the glacial soils for general farm crops. The Gloucester soils are well suited to the production of fruit, especially apples. The Wethersfield soils are good strong soils, but owing to their situation near the suburban districts of New York City they are not used extensively for farming. The loams and gravelly and stony loams are the most important types.

The Merrimac and Dunellen soils are good strong soils. The loam types are used for the production of general farm crops; the sandier types are excellent for truck crops, for which in some places they are extensively used. Many of the areas occupied by these soils are near the large centers of population and are used largely for building sites.

Muck is extensive, but as a whole has not been developed as it has been in other parts of the State. Its chief use at present is as pasture for dairy cattle during dry seasons.

The Whippany and Clyde soils need drainage and liming. The Clyde soils could be made to grow celery and lettuce if treated properly. At present these soils are used to some extent for general farm crops, though corn and clover do not do as well as many other crops. Large tracts of these soils are used for pasture.

The Chester soils are strong, productive, well-drained soils and very similar to the Gloucester soils. They are well suited to fruit production, especially peaches and apples.

The Hagerstown silt loam is the only type mapped in the Limestone Valley soil province, and is small in extent. It is an excellent soil for general farm crops, and seems well suited to the production of alfalfa.

The Piedmont Plateau soils are classed into two main divisions: (1) Those derived from sedimentary rocks, the Penn, Lansdale, Croton; (2) those derived from crystalline rocks, the Montalto and Watchung. Of the first group the Penn and Lansdale soils form good farm lands of about equal agricultural value. Some areas are of relatively

low value because the parent rock is too close to the surface and crops suffer from drought. The main types are the silt loams and shale loams, though the gravelly loams are important in places. The Croton silt loam is poorly drained and is not a popular farm soil. The shallow-rooted crops, such as rye, oats, and timothy, are the most successful. Corn, wheat, and clover do not do well.

The Montalto soils are well suited to fruit production and the growing of general farm crops. Many areas of these types are rather stony or occur on rough, broken topography. However, there are large tracts which are stone free, have a favorable topography, and are highly prized. The Watchung soils are the poorly drained equivalent of the Montalto, and in agricultural use are similar to the Croton soils.

The Sassafras and Elkton soils are mapped in the Coastal Plain province. The Elkton clay loam is poorly drained and low in agricultural value. The Sassafras soils are well drained and productive. The sandier types are highly prized in other sections of the State for truck crops. They occur in this area near the suburban sections and are not used to any great extent for farming. Large tracts have been dug over in mining the underlying clay deposits.

The soils of the River Flood Plain province are of many different kinds. Two second-bottom or terrace types are mapped—the Roanoke silty clay loam and the Birdsboro silt loam. The former is very poorly drained and is used mainly as pasture. The Birdsboro is developed on alluvial material derived from the Piedmont region. It is an excellent soil for wheat, clover, timothy, alfalfa, rye, and oats.

The first-bottom soils are used chiefly for pasturing dairy cattle. They are very well suited for pasture, as the grass remains green and fresh on them nearly the whole season. They are classed, according to derivation, in the Papakating, Podunk, Codorus, Wehadkee, and Bermudian series. The Papakating soils are the wettest and are used in most places for pasturing only during dry seasons, as they are inclined to be miry. The Bermudian silt loam represents the wash from the Penn and Lansdale soils of the upland and forms the largest acreage of first-bottom soils in the area. All the better-drained bottom soils are very productive, and, if it were not for the danger of overflows, could be made to produce very good yields of corn, wheat, and other general farm crops. Some of the larger bottoms are used for field crops, but even they often overflow.

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS
IN COOPERATION WITH THE
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
OF NEW JERSEY

SOIL MAP

NEW JERSEY
BERNARDSVILLE SHEET

LEGEND

- Bermudian silt loam (B)
- Montalto stony loam (Ms)
- Birdsboro silt loam (Bs)
- Montalto gravelly loam (Mg)
- Chester loam (Cm)
  - Stony phase (Cm)
  - Gravelly phase (Cm)
- Montalto silt loam (M)
- Papakating silt loam (P)
- Papakating silty clay loam (Pc)
- Clyde loam (C)
- Penn shale loam (Po)
- Codorus loam (Cl)
- Penn gravelly loam (Pl)
- Croton silt loam (Co)
- Penn silt loam (Ps)
- Dunellen sandy loam (Ds)
- Podunk loam (Pn)
- Dunellen loam (Dl)
- Roanoke silty clay loam (Rs)
- Elkton clay loam (Ec)
- Sassafras sand (Sa)
- Gloucester loam (Gl)
  - Stony phase (Gl)
  - Gravelly phase (Gl)
- Sassafras sandy loam (Sy)
- Sassafras loam (S)
- Washington loam (W)
  - Gravelly phase (W)
- Hagerstown silt loam (H)
  - Gravelly phase (H)
- Lansdale shale loam (Ls)
- Watchung silty clay loam (Wa)
- Lansdale gravelly loam (L)
- Wehadkee silty clay loam (Wc)
- Lansdale silt loam (L)
- Wethersfield gravelly loam (Wm)
- Merrimac sandy loam (Mr)
  - Gravelly phase (Mr)
- Wethersfield gravelly fine sandy loam (Wg)
- Whippany silty clay loam (Ws)
- Merrimac fine sandy loam (Mf)
- Muck (Mu)
- Merrimac loam (Mm)
  - Gravelly phase (Mm)
  - Intermediate phase (Mc)
  - Shallow phase (Mc)
- Tidal marsh (T)
- Rough stony land (R)

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwaters, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines: State, County
- Boundary lines: Land Grant, City or Village
- Boundary lines: Civil Township, Reservation
- U.S. township and section lines

RELIEF
(Printed in brown or black)

- Contours, Depression contours or Clay pits
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore, and Low-water line, Sandbar

DRAINAGE
(Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Very wet or Swampy areas
- Submerged and Tidal Marsh

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Soils surveyed by Austin L. Patrick, in charge and E. B. Deeter of the U. S. Department of Agriculture and C. C. Engle and L. L. Lee of the Department of Conservation and Development of New Jersey.

BASE MAP FROM DEPARTMENT OF CONSERVATION AND DEVELOPMENT OF NEW JERSEY ATLAS SHEET NO. 25 WITH CORRECTIONS.

Scale: 1 Mile to an Inch.
Miles: 1, 1¼, ½, ¼, 0, 1, 2, 3
Yards: 1000, 500, 0, 1000, 2000, 3000
Meters: 1000, 500, 0, 1000, 2000, 3000

Contour interval 10 and 20 feet.
Datum is mean sea level.

Field Operations
Bureau of Soils
1919